



Avian communities of managed and wilderness hemiboreal forests



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ABSTRACT

We compared breeding bird communities of hemiboreal forests in multiple-use managed forests and relatively unmanaged wilderness forests in northern Minnesota. A total of 240 point-count locations, 120 in each of the managed and wilderness areas, were sampled three times across ten paired transects in 2010 and 2011. Transects were paired near lotic systems that cross each management type, with half of the points adjacent to (100 m) or distant (400 m) from the riparian corridor. Total number of individuals and species richness detected per count were higher within the unmanaged forest ($F_{1,9} = 9.76$, $p = 0.01$; $F_{1,9} = 11.17$, $p < 0.01$) and forest adjacent to the riparian corridor ($F_{1,9} = 28.30$, $p < 0.001$; $F_{1,9} = 42.12$, $p < 0.001$). These results were negatively correlated with increased area of regenerating forests (mainly from logging) within the managed forest and positively correlated with tree species richness and over-story height of forest stands within the wilderness forest. Of 35 species analyzed individually, Black-capped Chickadee (*Poecile atricapillus*), Brown Creeper (*Certhia americana*), Canada Warbler (*Cardellina canadensis*), Golden-crowned Kinglet (*Regulus satrapa*), Least Flycatcher (*Empidonax minimus*), Red-breasted Nuthatch (*Sitta canadensis*), Winter Wren (*Troglodytes hiemalis*), and Yellow-bellied Flycatcher (*Empidonax flaviventris*) were more common in the wilderness forest. Only the Mourning Warbler (*Geothlypis philadelphia*) and Chipping Sparrow (*Spizella passerina*) were more common in the managed forest. Species associated with mature or mixed forests tended to be found in the wilderness area at higher densities, but most species associated with early-successional habitats did not differ between the managed and wilderness landscapes. Results suggest that forests with natural disturbance and succession regimes provide habitat for a higher density and richness of bird species. Responses by breeding birds were similar in both management types regarding distance from riparian areas. To adequately provide for effective conservation of the avian community, forested regions should include wilderness forests.

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1. Introduction

Few studies have compared breeding bird composition and abundance across a broad range of forest types and ages between naturally disturbed and managed boreal or hemiboreal landscapes (Edenius and Elmberg, 1996; Drapeau et al., 2000). In boreal regions, birds are estimated to compose approximately 70–80% of all terrestrial vertebrate species (Niemi et al., 1998) and the presence of natural heterogeneity in the ecosystem has caused bird species to adapt to diverse and changing landscapes (Heinselman, 1973; Pastor et al., 1996). Forest management might change these dynamics by altering the composition, age, and complexity of forest stands in the landscape.

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Fire disturbance has historically controlled the heterogeneity of boreal and hemiboreal forest ecosystems, but other natural disturbances such as wind-storms, periodic insect outbreaks, and beaver (*Castor canadensis*) activity have also been shown to affect the structure and diversity of landscapes (Heinselman, 1973; Pastor et al., 1996; Angelstam and Kuuluvainen, 2004; Kuuluvainen, 2009). The type, size, and intensity of disturbance have functioned in concert to maintain diverse species composition and ecological processes, but fire suppression efforts have resulted in human-induced changes replacing naturally occurring disturbances (Helle and Niemi, 1996; White and Host, 2008). To maintain ecological function and biodiversity, the effects of forest management must be understood and taken into account (Pastor et al., 1996; Reich et al., 2001). Logging has changed the scale and structure of landscape disturbance (Mladenoff et al., 1993; Schulte et al., 2007), but has also changed its rate (Heinselman, 1973). Historically, the rate of disturbance was highly variable while harvesting practices are at shorter, more regular intervals (Niemi et al., 1998).

Although fragmentation is often implicated in controlling species diversity and extinction patterns, research indicates that fragmentation plays a lesser role in altering the distribution and populations of boreal bird communities when compared with habitat loss (Schmiegelow et al., 1997; Trzcinski et al., 1999; Schmiegelow and Mönkkönen, 2002). Forest management does not permanently alter forests (Edenius and Elmberg, 1996), and forest cut-over areas often provide habitat for many breeding bird species preferring early-successional habitats (Schulte and Niemi, 1998). However, the degree to which logging mimics natural disturbance and its effects on forest dynamics has come under question (Hobson and Schieck, 1999). Hanski et al. (1996) found that increased amounts of edge due to logging had no negative effect on bird nesting success, but Manolis et al. (2002) and Flaspohler et al. (2001) found logging edges negatively affected ovenbirds (*Seiurus aurocapilla*).

Logging reduces structural diversity, vegetation diversity, and the presence of snags that are important to breeding bird communities (Niemi and Probst, 1990). Forest stands that are more diverse structurally and in tree species composition (Niemi and Hanowski, 1984; Hobson and Bayne, 2000b) provide habitat for a greater number of bird species and individuals to forage, breed, and nest. Species richness and density of individuals depend on many factors including forest type and disturbance type, but generally increase with forest stand age (Niemi et al., 1998; but see Hagan et al., 1997). Hobson and Bayne (2000a) and Venier and Pearce (2005) have also supported this pattern for quaking aspen (*Populus tremuloides*) and jack pine (*Pinus banksiana*) stands, respectively.

The objective of this study was to compare the breeding bird communities in forests managed by logging and relatively unmanaged wilderness forests. We also incorporate the influence of riparian corridors within this design because of the limited data that exist comparing riparian to upland systems (Bub et al., 2004), despite the importance of forested riparian corridors for bird communities (Hannon et al., 2002; Chizinski et al., 2011). We addressed three main questions. Do breeding bird communities of the Boundary Waters Canoe Area Wilderness (BWCAW, wilderness landscape) and the surrounding Superior National Forest (SNF, managed landscape) differ in abundance, composition, and diversity? How do effects of management type compare to those of a salient landscape feature, proximity to riparian corridors? What vegetation characteristics at the stand and landscape scale are associated with these differences?

2. Methods

2.1. Study area

The SNF comprises 1.6 million hectares in northeastern Minnesota. The BWCAW makes up approximately 400,000 hectares of the SNF and lies along the border with Ontario, Canada (Fig. 1). The BWCAW is a protected wilderness area, nearly half of which is virgin forest, with the remainder having been logged in the 1800s and early 1900s (Heinselman, 1996). Since the current BWCAW boundaries were designated in 1978, natural disturbances such as fire, windstorms, and insect outbreaks have affected the landscape. There is no logging management within the BWCAW, but prescribed burns and fire control are occasionally practiced. The remainder of the SNF lies south of the BWCAW. The U.S. Forest Service has adopted a multiple use protocol in this area, and development and management practices are prevalent, logging is common, motorized recreation is allowed, and homes and towns are present. Hereafter, BWCAW refers to the unmanaged wilderness area, and SNF refers to the managed area south of the BWCAW.

Hemiboreal regions of northeastern Minnesota are made up of diverse forest and other vegetative types, with thirteen recognized

upland cover types (Grigal and Ohmann, 1975), and eight lowland cover types (Heinselman, 1996). The most representative communities (by proportion coverage in the BWCAW) are fir (*Abies balsamea*)–birch (*Betula papyrifera*) forests, black spruce (*Picea mariana*) bog forests, black spruce–feathermoss (*Hypnaceae* spp.) forests, and maple (*Acer* spp.)–aspen (*Populus* spp.)–birch forests. The breeding bird communities of these hemiboreal forests, near the ecotone of boreal and northern temperate forests, are amongst the most diverse in North America (Niemi et al., 1998). This region supports approximately 155 breeding species of forest-dwelling birds (Green, 1995).

2.2. Study sites

Paired transects adjacent to river systems that cross the border of the BWCAW were established. We used aerial photography (Farm Services Administration Color Orthophotos 2003–2004) and land-cover maps (Landsat-based land-use land-cover) (MNDNR, 1999–2012) to identify study sites that fit criteria of being a lotic-system crossing the southern border of the BWCAW consisting of a minimum of 1.5 km of riparian habitat in both the BWCAW and SNF within 5 km of the BWCAW border (riparian habitat within 1 km of the border at an angle >45°). The habitat within 400 m of the riparian corridor had to be composed of mostly upland forest and commercial timber harvest had to have occurred on the SNF side after 1980. Ten areas spanning 138 km of the BWCAW border satisfied these criteria and were included (Fig. 1).

Each river system consisted of paired study areas, one within and one outside of the BWCAW, each a minimum of 500 m from the BWCAW border. Point counts within each study area were positioned along two parallel transects, 100 m and 400 m from the riparian corridor. Each transect consisted of six points spaced 250 m apart (Fig. 1).

2.3. Disturbance history

We summarized proportions of major habitat classes in a 1 km buffer surrounding each transect based on Landsat land-cover (Table 1). Forest cut-over areas were commercially harvested for timber between 1980 and 1995 and define the amount of younger forest. A regional analysis (Wolter and White, 2002) and recent field observations indicate the rate of forest management in this region is nearly 1% per year.

All transects within the BWCAW were likely disturbed by humans and cannot be considered virgin forest (Heinselman, 1973). Logging activities before the wilderness designation was mainly selective logging of old growth red (*Pinus resinosa*) and white pine (*Pinus strobus*). In nine of ten BWCAW transects, the most recent major disturbance was fire in the late 19th or early 20th century. The final transect was most recently disturbed by a logging operation in the early 1920s. Between 1975 and 2000, smaller-scale disturbance affected approximately 12% of the forests surrounding BWCAW count locations (Wolter et al., 2012), while forest management affected approximately 42% of locations in the SNF.

2.4. Avian surveys

At each point location, we conducted three ten-minute counts, with two between 14 May and 6 July 2010 and one between 25 May and 19 June 2011. All birds seen or heard (excepting those flying overhead) within the ten-minute interval were recorded and categorized by species, behavior (i.e., singing or calling), and distance from observer. Surveys were completed from approximately 0.5 h before sunrise to 4 h after sunrise in good weather conditions (no rain and low wind speed). In 2010, each pair of twelve points was surveyed twice by the same observer, at least 27 days apart.

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