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Benefits of aggregate green tree retention to boreal forest birds

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ABSTRACT

We evaluated the function of aggregate tree retention as mature habitat in a harvested matrix for boreal forest birds in a boreal mixedwood. We compared insular and peninsular residual patches ranging from 0.51 ha to 4.32 ha with plots in dispersed retention and intact forest to evaluate their usefulness to forest birds as habitat in a harvested matrix. We found that forest bird communities were significantly different in all three treatments and that bird communities in patches were an intermediate condition between intact forest and dispersed retention harvest. We observed 12 predominantly forest species, including Brown Creeper (*Certhia americana*), Ovenbird (*Seiurus aurocapilla*), Yellow-bellied Sapsucker (*Sphyrapicus varius*), and Black-throated Blue Warbler (*Setophaga caerulescens*), in patches at abundance levels between dispersed retention and intact forest plots. For these species, it appears that patches offer an important habitat in a harvested matrix but at lower abundance than in intact forest. Of the 12 predominantly forest species found in patches, 8 had confirmed breeding. Our results suggest that aggregate retention patches provide breeding quality habitat to a large group of forest species; however, the patches are not equivalent to intact forest suggesting that intact forest should be maintained in landscapes.

1. Introduction

Structural retention is a forest management practice where living and dead trees are left in the landscape after harvest to mimic forest condition following natural disturbance and maintain biodiversity (Franklin et al., 1997). There are three specific objectives of structural retention: (1) life boating, where retention provides habitat for mature forest species during succession; (2) providing structure and coarse wood to successional forests over the long-term; and (3) providing connectivity for mature forest species (Franklin et al., 1997; Rosenvald and Lõhmus, 2008; Gustafsson et al., 2012). A fourth objective should also be considered; providing necessary structure for otherwise open habitat species (Swanson et al., 2011). In this paper we mostly evaluate the first of these objectives, although we also provide evidence of the use of forest structure in patches by open habitat species (objective 4).

Tree retention can take many forms including: aggregate retention, leaving patches of trees on clearcuts; dispersed retention, leaving individual trees dispersed over the clearcut; and variable retention, a mixture of these two strategies. The degree of retention can also vary widely. For example, existing guidelines suggest levels of retention from 3% to 10% in Michigan (Bielecki et al., 2006), 10% to 28% or more in Ontario (OMNR, 2001) and 15% in the Pacific Northwest (Aubry et al., 1999), while in experimental settings as much as 75% of trees have been retained (Aubry et al., 1999; Vanderwel et al., 2007). As a result it is very difficult to talk about the effects of tree retention without specifying its form and degree.

In a meta-analysis of the effects of uniform partial harvesting on birds (equivalent to uniform dispersed retention), Vanderwel et al. (2007) found relatively large declines in abundance of 14 species relative to uncut sites at retention levels ranging from 15% to 85%. This is not surprising since dispersed retention is less likely to maintain mature forest structure than is aggregate retention

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in patches. In patches, all trees are retained, albeit for a smaller total area than for dispersed retention and understory and microclimate are preserved to a greater degree. We expect that aggregate retention will be better at providing some habitat for older forest species whereas dispersed retention will be better at providing more widely dispersed future structure to regenerating forests over larger scales and longer time frames as well as providing immediate structure to some open habitat species (Swanson et al., 2011). The maintenance of forest bird species appear to require very high levels of dispersed retention (>40% of trees) (Tittler et al., 2001). A recent meta-analysis by Fedrowitz et al. (2014) did not detect differences in biodiversity response between dispersed and aggregate retention. However, the authors provided several caveats for why this conclusion is not well founded, including having used a limited amount of data that required all taxonomic groups from lichens to birds to be examined in the same analysis. They noted evidence in the literature that response to retention pattern is taxon specific (Fedrowitz et al., 2014).

Previous studies have suggested that bird communities in retention forest are not the same as communities in mature or old-growth forest (Merrill et al., 1998; Preston and Harestad, 2007; Atwell et al., 2008). However, studies have also demonstrated that forest patches can provide habitat for at least some forest species (Hansen et al., 1995; Schmiegelow et al., 1997; Seip and Parker, 1997; Merrill et al., 1998; Schieck and Hobson, 2000) although in all of these studies only occupancy or abundance were examined. In this study, we compared boreal bird abundance and breeding in residual forest patches with plots of dispersed retention and intact forest during the breeding season. We hypothesized that some forest dependent species would breed successfully in forest patches if patches are of sufficient size to provide mature forest structure. We also hypothesized that forest patches would be intermediate between the dispersed retention and intact forest plots in providing breeding habitat for the more forest-dependent bird species due to edge effects.

2. Study area and methods

2.1. Study area

This study was conducted in the boreal forest (Rowe, 1972) of northeastern Ontario, Canada approximately 50 km south of Timmins (48.219, −81.355). Parent materials on the study area are primarily glacial–fluvial/morainal origin, with generally mild terrain and with high quality soils. The pre-harvest stands in the study area were mainly upland mixedwoods. The most commonly occurring types were red maple (*Acer rubrum* L.) mixedwood (~20%) and, trembling aspen (*Populus tremuloides* Michx.) – white birch (*Betula papyrifera* Marsh.) (~17%). Conifer-dominated stands were most consistently represented by cedar (*Thuja occidentalis* L.) – black spruce (*Picea mariana* (Mill.) Britton) with organic soil (~14%) and white spruce (*Picea glauca* (Moench) Voss) – balsam fir (*Abies balsamea* (L.) Mill. – cedar (10%). There were also isolated patches of white pine (*Pinus strobus* L.) and yellow birch (*Betula alleghaniensis* Britt.) at 5% each. Although this site is in Rowe's (1972) boreal forest region, many of these tree species are common in the area of boreal – temperate hardwood transition.

The primary study area is 528 ha and was harvested in 2005 (192 ha) and 2006 (191 ha) (Fig. 1). Of the unharvested area, 62.6 ha were retained as aggregate retention patches. These patches include both insular patches (surrounded by cutover) and peninsular patches (cutover on three sides). We chose a minimum of 0.5 ha patches and 10% total area representation because these values meet the guidelines set out by the Ontario Ministry of Natural Resources in their Forest Management Guide for Natural Disturbance Pattern Emulation (OMNR, 2001). Aggregate retention of residual trees was used to improve wind resistance of residuals, increase mechanical site preparation coverage and thus achieve higher stocking of planted seedlings, and facilitate the delivery of more efficient and effective aerial tending. Aggregate retention was achieved through the use of pre-planned "islands" of intact forest, representative of the tree species and stand types of the harvest block. A 10.4 ha parcel in the study area was harvested using dispersed retention. Total aggregate retention of residuals on the block accounted for 14.5% of the total area (431.5 ha), thus meeting pre-harvest targets.

2.2. Study design

We conducted surveys at 24 plots, eight each of three forest treatment types including aggregate retention ("patch"), dispersed retention ("cut"), and intact forest ("forest") (Fig. 1). Patches ranged from 0.51 ha to 4.32 ha in size (X = 1.86, SD = 1.13). Ecosystem type at intact forest and cut plots was similar to patches based on overstory and understory tree species present at the time surveys were conducted (or prior to harvesting in the case of cut plots). Cut plots were all recently harvested (not more than two years prior to bird sampling) and residual trees were retained at a density of 25 stems per ha. Details of study site establishment can be found in Pitt et al. (2008). We established a 100 m × 100 m sampling grid in each plot. All patches were located on the harvest block (Fig. 1). Seven of eight forest plots are in the immediate vicinity of the primary cut block, the eighth is approximately 20 km west of the cut block. Three of the cut plots are located on the cut block (Fig. 1), one is approximately 20 km west of the cut block, and the remaining four are approximately 5 km south of the cut block.

2.3. Bird sampling

We conducted point counts, transect surveys, and nest searches in all 24 plots (8 × 3 treatments) in 2007. In 2008 we conducted point counts in all three treatments but conducted transect surveys and nest searches only in patches and forest treatments. In 2009 we conducted point counts in all treatments but conducted transect surveys and nest searches only in the patches.

2.3.1. Point counts

Point counts were conducted at the same location, in the approximate center of the plot two times each year. In 2007 and 2008, ten minute point counts were conducted by two observers, KLD and PJG. In 2007, first visits were made to all 24 plots on June 6–11. A second visit was made to each plot during July 4–14. In 2008, first visits were made on June 1–4, second visits were made June 23–27. In 2009, counts were conducted by KC, first visits were made June 11–13, and second visits were made June 27–29. All point counts were conducted between 30 min before and 3 h after sunrise. Counts were not conducted during rain or excessive wind (>3 on Beaufort scale). All birds seen or heard were recorded. The maximum count for the two visits was used as an index of abundance at that plot for each year.

2.3.2. Transect surveys and nest searches

Within the sampling grid, transect lines were located and marked every 20 m. Grid lines were walked slowly and location, sex, and breeding evidence was recorded for each bird observed (see Table 1 for a list of breeding evidence). Transect surveys were conducted 4–6 times per breeding season at each plot. During transects surveys, nesting activity was noted and birds were followed to determine reproductive status. Nests were monitored every 3 days to determine evidence of breeding. Transect surveys were conducted from May 13 – July 14 (2007), May 23 – July 7 (2008),