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Cavity and bark nesting bird response to partial cutting in Northern conifer forests

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ABSTRACT

We investigated whether partial cutting used to mimic small-scale natural disturbances could maintain cavity and bark nesting breeding birds. We assessed changes in the relative abundance of cavity nesting birds in two intensities of partial cutting, compared to uncut and clearcut stands, 9 years post-treatment. We then examined the relationship between forest structure and nesting abundance (stand scale) and compared characteristics of used nest and forage trees to unused trees (tree scale). The relative abundance of most species was highest in either heavy removal or light removal treatments 9 years post-harvest. Brown creepers were most abundant in uncut, and red-breasted sapsuckers were most abundant in clearcut and heavy removal treatments. The proportion of deciduous trees and the density of dead trees were the best predictors of nest abundance. Individual nest tree use was predicted by the presence of large deciduous trees with broken tops and early to advanced stages of decay. Forage tree use was predicted by the presence of large conifer trees in advanced stages of decay. To maintain breeding habitat for cavity nesters, we suggest that forest managers retain the specific structural attributes required for nesting, but also the diverse forest conditions required for foraging.

1. Introduction

Within forest ecosystems, cavity-nesting species play a crucial role in structuring vertebrate communities (Martin and Eadie, 1999). Species are classified into guilds that describe how they acquire a cavity. Primary cavity excavators are woodpeckers that excavate their own nests, while secondary cavity nesters are the songbirds, ducks, raptors, and mammals that use the cavities created by primary cavity excavators as well as natural cavities. Weak cavity excavators are species such as nuthatches and chickadees, which can excavate their own cavities in soft wood or renovate natural or previously excavated cavities. Bark nesters are species such as creepers which build a hammock-like nest under a loose piece of bark. These interdependent guilds form a "nest web" where the community is structured around nest-site resource availability (Martin and Eadie, 1999; Aitken et al., 2002; Martin et al., 2004). Since approximately 25–30% of forest vertebrates in the Pacific Northwest of North America nest or roost in cavities (Bunnell et al., 1999), maintaining the structure and function of the cavity nesting community is necessary to sustain vertebrate diversity within forest stands.

Stand level characteristics associated with cavity nester communities can include sparse forests with an open understory (Hagar et al., 1996; Lawler and Edwards, 2002; Aitken and Martin, 2004), diverse stand structure (Adams and Morrison, 1993; Beese and Bryant, 1999), large trees (Mannan and Meslow, 1984; Harestad and Keisker, 1989; Chambers et al., 1999), live trees (Dobkin et al., 1995; Aitken and Martin, 2004), standing dead trees (Schreiber and deCalesta, 1992; Spiering and Knight, 2005; Mahon et al., 2007), and trees with fungal infections (i.e., stem rot) that can result in soft heartwood (Harestad and Keisker, 1989; Dobkin et al., 1995; Martin et al., 2004). Intensive even-aged forest management often removes the live, unhealthy, and dead trees required by cavity nesters for nesting and foraging potentially altering the structure and function of the cavity nesting community (Waterhouse and Armleder, 2007).

Uneven-aged harvest systems (e.g., selection cutting, patch retention) can be used to simulate a variety of natural disturbance events operating within forest systems. Small-scale natural disturbances occur when individual or small groups of trees die and fall over creating diverse structural attributes (broken limbs, broken tops, wound sites) and small canopy gaps. These frequently occurring events caused by wind, disease, or insect attack result in

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complex stands with high spatial and structural diversity and may provide breeding habitat for those cavity nesters associated with mature and old forest structural stages like the pileated woodpecker (*Dryocopus pileatus*), American three-toed woodpecker (*Picoides dorsalis*), chestnut-backed chickadee (*Poecile rufescens*), red-breasted nuthatch (*Sitta canadensis*), and brown creeper (*Certhia americana*). Mature forests are dominated by the initial post-disturbance tree cohort, although canopy gaps are beginning to appear. Old forests are dominated by the initial post-disturbance cohort that is declining in vigor. Frequent canopy gaps result in a range of tree sizes and ages and a high degree of spatial and structural complexity within stands (British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands, and Parks, 1998).

Conversely, large-scale natural disturbances like fire result in remnant tree patches surrounded by herbs, shrubs, young saplings and damaged trees and may provide breeding habitat for cavity nesters associated with open, woodland habitats like the northern flicker (*Colaptes auratus*) or post-burn habitats like the black-backed woodpecker (*Picoides arcticus*) (Schieck and Song, 2006). Partial cutting, which we define as any harvest treatment that retains standing trees, can be used to mimic either small-scale disturbances (using single or group tree selection) or larger-scale disturbances (using group or patch retention). The pattern (clumped or dispersed) and intensity (proportion of stand removed) of the partial cutting treatment can result in varying stand conditions for cavity nesting birds. A key distinction of partial cutting vs. natural disturbance in terms of potential bird response is the removal of harvested trees.

In northwest British Columbia, forest managers have used single and group-tree selection harvesting at two intensities to mimic the small-scale natural disturbance events that operate in these forests. Initial results (1 and 2 years post-treatment) suggested that cavity or bark nesting species like the American three-toed woodpecker, chestnut-backed chickadee, red-breasted nuthatch, and brown creeper had higher relative abundance in light removal (30% volume removal) or heavy removal partial cut stands (60% volume removal) compared to uncut and clearcut stands (Steventon et al., 1998). Although these results were encouraging, additional questions remained: (1) could cavity nester richness and relative abundance be maintained in partial cut stands over time, (2) were cavity nesters actually breeding within partial cut stands, and (3) what structural attributes were used by cavity nesters for nesting and foraging? We define richness as the total number of cavity nesting species in the study area, while relative abundance (rough estimate of population density) is the number of individuals of a certain species detected in the study area (Dunster and Dunster, 1996). Due to differences in body size and life history characteristics, cavity nesters utilize a variety of nesting and foraging sites. Identifying the habitat attributes used by these species for nesting and foraging can enable managers to maintain these attributes within managed stands.

In this paper, we further investigate the role of partial cutting in maintaining the richness and relative abundance of breeding cavity-nesting birds. We first examined the relative abundance of cavity nesting birds in two intensities of partial cutting, 9 years post-treatment, compared to uncut and clearcut stands for the same area as Steventon et al. (1998). We then examined in more detail the relationship between forest structure and cavity nesting birds at two scales using a multi-year study of cavity nesting birds. At the stand scale (coarse-grained), we examined the relationship between forest structure and nesting abundance of cavity nesting birds. At the tree scale (fine-grained), we compared characteristics of used nest and forage trees to unused trees.

2. Study area

The McCully Creek watershed is located in northwest British Columbia, Canada (55°22′N, 127°50′W) approximately 35 km north of the town of Hazelton in the Interior Cedar-Hemlock moist cold (ICHmc) biogeoclimatic subzone (150–1000 m elevation) within the coast-interior transition area (Banner et al., 1993). Mature forests (140 years) within this temperate, humid environment were dominated by western hemlock (*Tsuga heterophylla*) but also included western redcedar (*Thuja plicata*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), hybrid spruce—the complex of white spruce (*Picea glauca*), Sitka spruce (*P. sitchensis*), and Engelmann spruce (*P. engelmannii*), paper birch (*Betula papyrifera*), trembling aspen (*Populus tremuloides*), and black cottonwood (*P. balsamifera*). Amabilis fir (*Abies amalilis*) also occurred at higher elevations. Old-growth forests (250 to 300+ years) were dominated by western hemlock with major components of sub-alpine and amabilis fir, and western redcedar. Zonal ecosystems consisted of a thick moss layer dominated by feather mosses and a poorly developed herb and shrub layer (Coates et al., 1997). Natural disturbance patterns in the ICHmc were characterized by frequent low intensity gap forming disturbances at the individual tree scale (Coates and Burton, 1997), as opposed to large, stand-initiating disturbances like fire which occur, on average, at 200-year intervals (Coates et al., 1997). Within the understory reinitiation stand development stage (mature and old growth structural stages) treefall gaps of various sizes are created continuously as a result of natural tree mortality, wind, and attack by fungi and insects (Coates et al., 1997; Steventon et al., 1998). Important fungi included heart rots like red ring rot (*Phellinus pini*), red belt fungus (*Fomitopsis pinicola*), and indian paint fungus (*Echinodontium tinctorium*), and root rots like tomentosus root rot (*Inonotus tomentosus*) and Schweinitzii butt rot (*Phaeolus schweinitzii*), while attacking insects included mountain pine beetle (*Dendroctonus ponderosae*), spruce beetle (*D. rufipennis*), western balsam bark beetle (*Dryocoetes confusus*), western hemlock looper (*Lambdina fiscellaria lugubrosa*), and 2-year-cycle budworm (*Choristoneura biennis*) (Banner et al., 1993).

Forest managers responsible for the area used partial cutting to mimic small-scale natural gap creation events that occur within mature and old forest stands in the ICHmc. They removed trees across all diameter and species classes as single trees and small groups of trees to create canopy gaps that closely resembled the natural treefall gaps created when a stand enters the understory re-initiation or gap dynamic stand development stage (Coates et al., 1997). Regeneration within gaps occurred due to the ability of both shade tolerant western hemlock and light-demanding trembling aspen and lodgepole pine to grow within these open habitats.

2.1. *Cavity nesting bird response to partial cutting: relative abundance*

The long-term study examining bird abundance in response to partial cutting was conducted at the Date Creek research site within the McCully Creek watershed during 2002. We examined four treatments with four replicates of each treatment (16 treatment units 20 ha each containing 50 m × 50 m grid systems) in a randomized block design. Treatments consisted of uncut forest (UC), clearcut forest (CC), light removal (LR; approximately 30% of the stand volume as single trees or small patch cuts), and heavy removal (HR; approximately 60% of the stand volume with 30% in openings of 0.1–0.5 ha and 30% as single trees between openings). The blocking factor was a combination of ecological site type and age of forest in 1991 (mesic 135 years; mesic-