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Comparison of breeding bird and vegetation communities in primary and secondary forests of Great Smoky Mountains National Park

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ABSTRACT

We compared breeding bird communities and vegetation characteristics at paired point locations in primary (undisturbed) and mature secondary forest (70–100 years old) sites in Great Smoky Mountains National Park, USA to understand how sites logged prior to creation of the park compare to undisturbed sites following 70 years of protection from human disturbance. We found that bird and vegetation communities are currently similar, but retain some differences in species composition. Rank abundance curves for primary and secondary forest bird communities showed very similar patterns of species dominance. Species composition was also similar on the two sites which shared 24 of the 25 most frequently recorded species. Nonetheless, comparisons of density estimates derived from distance sampling showed three bird species were more abundant on primary forest sites and that one bird species was significantly more abundant on secondary forest sites. Notably, comparisons based on raw counts (unadjusted for potential differences in detectability) produced somewhat different results. Analyses of vegetation samples for the paired sites also showed relative similarity, but with some differences between primary and secondary forests. Primary forest sites had more large trees (trees greater than 50 cm diameter at breast height) and late successional species. Primary forest sites had a denser tall shrub layer while secondary forest sites had a denser canopy layer. Nonetheless, tree species richness, basal area of live trees and number of standing snags did not differ between primary and secondary forest sites. Results indicate that breeding bird communities on sites within the park that were logged commercially 70 years ago are currently quite similar to bird communities on sites with no history of human disturbance. Similarities between the bird communities on previously disturbed and undisturbed sites in Great Smoky Mountains National Park may exceed those on more fragmented landscapes because large patches of primary forest, adjacent to commercially logged sites, remained in the park when it was established in 1935. These patches of primary forest may have served as source areas for commercially logged sites.

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1. Introduction

Many studies have documented differences in animal species community structure and composition on old-growth and second-growth forest sites (e.g., Haney, 1999; Jung et al., 1999; Okland, 1996; Thompson et al., 1999; Lomolino and Perault, 2000; Martikainen et al., 2000; Blake and Loiselle, 2001; Hyde and Simons, 2001). Similarly, many studies have investigated animal community responses to silvicultural practices (e.g., Morrison, 1992; Herbeck and Larsen, 1999; Sallabanks et al., 2000). Most comparative studies have focused on differences between early second-growth and old-growth, or early and late second-growth forests (e.g., Diaz et al., 2005). Comparative studies are often constrained by a lack of replication and the difficulty of pairing small and widely scattered remnants of old forest with comparable sites that have regenerated from previous clearing. Few studies have examined animal community differences between undisturbed primary forest and mature second-growth forests (but see Herbeck and Larsen, 1999; Hyde and Simons, 2001). Such comparisons are an important step in identifying the point at which wildlife species no longer discriminate habitat differences associated with historic land use.

Animal community differences along successional gradients are generally attributed to changes in vegetation structure and composition (Thompson et al., 1999, 2003). Comparisons of old-growth and mature second-growth temperate forests have shown that forests regenerated over the last century have developed many of the structural characteristics of old-growth (Schuler and Gillespie, 2000; Ziegler, 2000). Despite measurable differences between old-growth and second-growth forests, there is no general agreement on a definition of old-growth (Leverett, 1996; White and White, 1996). Assigning an age-based definition is problematic because different forest types are dominated by species with differing life history parameters. Furthermore, researchers do not agree on whether or not forests that have undergone widespread natural disturbance, but have not been altered by human disturbance, should be defined as old-growth (Leverett, 1996; White and White, 1996). White and White (1996) argue that forests that are relatively young due to natural disturbance should be considered old-growth because they contain undisturbed soils and characteristic amounts of coarse woody debris, and because such forests are important and natural elements of old-growth forest mosaics. Moreover, Runkle (2000) showed that while undisturbed old-growth forests in the eastern United States change very slowly over time, they are always in a state of flux.

Despite these issues, most researchers agree on the general characteristics of old-growth forests, such as old trees, large trees, woody debris, high density of snags, canopy gaps, pits and mounds, identifiable growth layers, late successional species, and lack of human disturbance (Leverett, 1996). These features provide unique structural habitat characteristics that have been identified in several studies as offering optimum conditions for North American bird species such as Red-breasted Nuthatch (*Sitta canadensis*), Brown Creeper (*Certhia americana*), Winter Wren (*Troglodytes troglodytes*), and Golden-crowned Kinglet (*Regulus satrapa*) (Haney et al., 2001), as well as the Rufus Treecreeper (*Climacteris*

rufa) in western Australia (Luck, 2002), and the Eurasian Treecreeper (*Certhia familiaris*) in central Finland (Suorsa et al., 2005).

Great Smoky Mountains National Park, USA includes more than 45,000 ha of primary forest that lack evidence of direct human disturbance from timber harvest, settlement, or agriculture (Pyle, 1985; Davis, 1996). Although these forests are considered old-growth, most areas have been subject to large scale natural disturbances at some point in the past. Natural disturbances have included extensive fire, windstorms, ice and snow storms, landslides, and insect outbreaks (SAMAB, 1996; Greenberg and McNab, 1998). Furthermore, exotic pests and the loss of predators have influenced forest structure and composition. Invasions of chestnut blight (*Endothia parasitica*) and balsam woolly adelgid (*Adelges piceae*) have led to the eradication of American chestnut (*Castanea dentata*) and Fraser fir (*Abies fraseri*) as canopy trees in most forests of the southeast (Liebhold et al., 1995). The loss of large predators and subsequent increases in deer and feral hog populations have altered understory communities (SAMAB, 1996). Nonetheless, these forests retain essential qualities of primary forest (Busing, 1998) and are characterized by diverse plant and animal populations. Great Smoky Mountains National Park, like much of the southern Appalachians region, also contains forests regenerating from the extensive industrial logging that took place in the early part of the twentieth century (Pyle, 1985; SAMAB, 1996; Yarnell, 1998).

Hyde and Simons (2001) showed that salamander populations are more abundant and salamander communities are more diverse on undisturbed sites compared to mature second-growth sites in Great Smoky Mountains National Park. Furthermore, several salamander species show strong positive associations with undisturbed sites. While no similar study has been conducted on breeding birds in the southern Appalachians, Haney (1999) documented increased abundance of several bird species in old-growth forests of the Allegheny Plateau in Pennsylvania, USA compared with the surrounding landscape.

In this paper we report on breeding bird community structure and composition in primary forest (undisturbed old-growth) and mature secondary forest (70–100 years post logging) in Great Smoky Mountains National Park. We compare the two forest types to investigate whether bird communities on mature second-growth sites are indistinguishable from those on undisturbed sites, or if community differences continue to persist after 70–100 years of regeneration. Similarly, we evaluate vegetation composition and structure to identify factors potentially associated with differences in bird communities. We also discuss the importance of adjusting for differential detectability when point count surveys are used to compare breeding bird communities in different habitats. Although increasing attention has been focused on the need to use sampling and analytic methods that account for habitat or species-specific differences in detection probabilities (Buckland et al., 1993; Lancia et al., 1994; Thompson et al., 1998; Yoccoz et al., 2001; Rosenstock et al., 2002), relatively few studies (e.g., Boulinier et al., 2001) incorporate such methods, and none have demonstrated habitat specific differences in detection probabilities.

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