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The effects of Forest Stand Improvement Practices on occupancy and abundance of breeding songbirds

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ABSTRACT

Silviculture can play an important role in managing avian habitat. In 2010 the Vermont Natural Resource Conservation Service, in conjunction with Audubon Vermont, implemented a Forest Stand Improvement initiative designed to improve timber quality while increasing habitat diversity for forest breeding songbirds. To evaluate the effectiveness of this program in improving avian habitat, we conducted point count surveys of breeding birds in harvested and control sites in 2012 and 2013, 1–3 years post-harvest. Harvesting resulted in mean decreases of 18% in basal area, 10% in canopy cover, and 10% in canopy tree density while piles of woody debris per ha increased by 402%. Occupancy and abundance estimates for 24 and 18 bird species respectively were derived using Program MARK. Compared to controls, occupancy rates of four songbird species were greater on harvested sites – rose-breasted grosbeak (*Pheucticus ludovicianus*), yellow-bellied sapsucker (*Sphyrapicus varius*), chestnut-sided warbler (*Setophaga pensylvanica*), and mourning warbler (*Geothlypis philadelphia*)—while occupancy of one species—black-and-white warbler (*S. fusca*)—was significantly lower. Two species were significantly more abundant at harvested sites—rose-breasted grosbeak and yellow-bellied sapsucker—while two species were less abundant—hermit thrush (*Catharus guttatus*) and black-and-white warbler. Piles of woody debris left after harvests were negatively associated with site occupancy for 3 out of 10 understory species. Overall, our results suggest that this program retains all interior forest species and has a slight positive impact on gap and early successional species abundance and occupancy in the first 1–3 years post-harvest. This study provides the first quantitative examination of the impact that Vermont NRCS's Forest Stand Improvement program has had on forest breeding birds.

1. Introduction

Approximately 80% of the northeastern United States is covered by forests (Drummond and Loveland, 2010). Much of its forest is comprised of even-age aged second-growth, the result of past land clearing and subsequent abandonment, reforestation and forestry management (Keeton, 2006). Compared with old growth forests, these young and maturing forests exhibit lower levels of structural complexity, smaller canopy gaps and less understory structure, and they represent a less complex mosaic of disturbances, early successional patches and canopy gaps (North and Keeton, 2008). As a result of historic land management practices that removed the best quality trees and resulted in overcrowding of small trees, the timber quality tends to be of less value for forestry (Natural Resource Conservation Service, 2011) and may be of lower quality for forest breeding birds than more structurally complex habitat (DeGraaf et al., 1998). Since many of these forests are on private land (Foster et al., 2010), landscape level management is complicated by differing land uses and goals. In recognition of this complication, the Vermont Natural Resource Conservation Service (NRCS), in cooperation with Audubon Vermont, and the Vermont Department of Forests, Parks and Recreation, has instituted a new set of treatments for the Forest Stand Improvement (FSI) Conservation Practice to improve forest health and productivity while simultaneously enhancing forest bird and wildlife habitat (Natural Resource Conservation Service, 2011). These new treatments, started in fall of 2011, were funded through the Farm Bill Conservation Programs including the Wildlife Habitat Incentives Program (WHIP) and the Environmental Quality Incentives Program (EQIP). This was commonly referred to as the 'Forest Bird Practice' (formal name – Integrating Timber/Songbird Habitat Mgt.).

The FSI treatments were generally implemented as small scale (typically 2–15 ha) pre-commercial thinnings in even or two aged stands lacking a well-developed understory and midstory with low

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habitat diversity and few large diameter high quality trees (Natural Resource Conservation Service, 2011). When a landowner enrolls in a Conservation Program for FSI, a management plan is developed, in concert with the landowner's forest management plan, to characterize the stand and surrounding landscape and determine which type of management is best for each forest patch, as many bird species respond differently to stand level changes in habitat (Smith et al., 2008). Some firewood or pulpwood may be taken from the stand but little saw quality timber is removed. The Forest Bird Practice treatments are designed to leave at least 70–80% of crown closure intact, reduce crowding and unacceptable growing stock, and to create some gaps to increase regeneration for understory-nesting species (Natural Resource Conservation Service, 2011). However, the treatments aim to leave enough of the forest canopy intact to retain habitat for interior nesting birds. Tree tops and branches are left behind as slash/brush piles to provide singing perches, nesting, cover and foraging habitat for ground nesting and foraging species.

The primary focus of the Forest Bird Practice treatments is to improve forest bird habitat and structure while also improving forest health and timber quality. As part of the cooperative 'Foresters for the Birds' project between Audubon Vermont and the Vermont Department of Forests and Parks, Audubon Vermont has identified a suite of 40 priority bird species whose habitat needs the program considers (Hagenbuch et al., 2011a). Species that nest in structurally complex closed canopy forests with small gaps are expected to be primary beneficiaries of this program. Recommendations were made based on existing knowledge of the impact of silvicultural practices on birds; however, the effects of this program on birds have never been tested. Our goal was to investigate the response of birds to broad-scale management programs in order to evaluate the effect of these practices (sensu Perlut et al., 2011). Population declines in many forest breeding birds are well documented (Robbins et al., 1989; Rich et al., 2005; Valiela and Martinetto, 2007), and concern has been raised both about declining early and mid-successional species in maturating forests (Hunt, 1998; Holmes and Sherry, 2001; DeGraaf and Yamasaki, 2003) and the deleterious effects of clearcutting on forest interior species (Thompson et al., 1992; Therres, 1993; King and DeGraaf, 2000; Haulton, 2008). Selection systems (e.g. single tree and group selection) through uneven-aged forest management have been suggested as an alternative to clearcutting that retains forest interior species and still attracts species needing a structurally complex understory (Jobes et al., 2004; Campbell et al., 2007; Norris et al., 2009).

Forest breeding birds respond in a variety of ways to single tree and group selection harvests (Vanderwel et al., 2007), but generally mature or forest interior species are either unaffected or decline only slightly after selection harvests (Lent and Capen, 1995; Jobes et al., 2004) because much of the forest canopy remains intact and basal area is not reduced as much as in more intensive logging. However, some forest interior species such as ovenbird (*Seiurus aurocapillus*) and red-eyed vireo (*Vireo olivaceous*) may decline if the basal area is reduced below 20 m^2/ha (Holmes and Pitt, 2007). Early successional species increase in response to forest openings (Lent and Capen, 1995; Holmes and Pitt, 2007) following the regeneration of shade tolerant understory species (Costello et al., 2000; Jobes et al., 2004). Some early successional specialists that require large canopy gaps will likely remain unaffected by the relatively small gaps created by the FSI, such as eastern bluebird (*Sialia sialia*) or indigo bunting (*Passerina cyanea*) (Costello et al., 2000). Nonetheless, shrub nesting and early successional species have been documented to increase when small openings of 0.02–0.4 ha are created (Germaine et al., 1997; Campbell et al., 2007). Forestry treatments may also impact the litter and leaf dwelling arthropods that birds prey upon (Shure and Phillips, 1991; Harper and Guynn, 1999), affecting territory quality for insectivorous birds. The FSI methods evaluated in this study were designed to retain as many interior forest species as possible by limiting the amount of canopy basal area reduction and canopy openness, and thus they may recruit only limited number of early successional species.

The objective of this study was to quantify the short term (1–3 years post-harvest) effects of the FSI program on occupancy and abundance of forest breeding birds in Vermont. In order to document the structural changes caused by harvest, we evaluated five stand-level attributes and two measures of local arthropod biomass. Our goals were to (1) determine how the abundance and occupancy rates of forest breeding birds differed between treatment and control stands, and (2) examine how changes in vegetation structure and understory arthropod biomass influenced occupancy and abundance of individual species. Specifically, we hypothesized that due to the light nature of the harvests, forest interior, midstory and canopy nesting species would remain unaffected but that the canopy openings created would cause gap and understory nesting species to increase in harvested stands. We further hypothesized that changes in vegetation characteristics at harvested sites would explain increases in occupancy and abundance of ground and understory nesting species. Our goal is to provide managers and foresters with a better understanding of how the structural changes caused by this program impact bird communities. This study is the first to quantify the short term impact of the FSI program and provides an analytical framework for further studies assessing the long-term effects of this program in Vermont and other regions.

2. Materials and methods

2.1. Study area

We surveyed stands on 23 properties across northern and central Vermont, USA, in Franklin, Lamoille, Essex, Orleans, Chittenden, Addison and Orange counties. All properties were enrolled in NRCS Conservation Programs (WHIP or EQIP) for the Forest Stand Improvement Practice and were treated between December 2010 and February 2013. Of the options offered through the Forest Bird Treatments the following were planned and implemented: (1) crop tree release with canopy gap formation ($n = 7$), (2) expanding gap group shelterwood ($n = 3$), and (4) small group selection ($n = 1$). The Pole Sized Thinning treatments were planned and implemented at a much greater rate ($n = 17$). Due to the small sample size and similarity of treatment effects on the ground, the Forest Bird Practice treatment and Pole Thinning treatments were combined for this study. The harvested areas ranged from 2 to 25 ha (mean 6.7 ha) and were classified as either northern hardwoods or mixed northern hardwoods, located within a primarily forested landscape. Stands were either even-aged or two-aged second-growth forest 40–100 years old ranging in elevation between 200 and 670 m. Matched control stands of similar forest type and management history were selected for each harvested stand, and were located on the same or adjacent property >100 m from harvested stands. Some stands were scheduled to be harvested but harvests were not completed until after the study was complete, so those stands were lumped with controls. This resulted in a total of 15 harvested and 46 unharvested stands surveyed in 2012. Thirteen of the unharvested stands were harvested in 2013, resulting in 28 harvested and 33 unharvested stands surveyed in 2013. Dominant trees on the sites included sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), American beech (*Fagus grandifolia*), ash (*Fraxinus sp*), big-toothed aspen (*Populus grandidentata*), white pine (*Pinus Strobus*), eastern hemlock (*Tsuga canadensis*), eastern hophornbeam (*Ostrya virginiana*), black cherry (*Prunus serotina*),