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A bird's-eye view of forest restoration: Do changes reflect success?

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ABSTRACT

To understand the ecological effects of forest restoration treatments on several old-growth forest stands in the Flathead National Forest of western Montana, USA, we surveyed birds at 72 points in treatment and control stands, and at more than 50 points in each of five potential reference stand conditions. We used a Before–After/Control-Impact design to assess treatment effects based on data collected 3 years before and 2 years after treatment. We also examined the similarity in bird community composition among all stand types by using a nonmetric multidimensional scaling approach. Relative abundances of only a few bird species changed significantly as a result of restoration treatments, and these changes were characterized largely by declines in the abundances of a few species associated with more mesic, dense-forest conditions, and not by increases in the abundances of species associated with more xeric, old-growth reference stand conditions. Thus, bird communities in treated stands were more similar to those in untreated stands of the same forest type than to those found in any of the potential old-growth reference stands. Although more time may be required for some bird species to respond to treatments, our results suggest that treatment plot sizes were either too small to affect bird communities or that the forest type selected for treatment was not within the range of forest types that are well suited for this type of forest restoration.

1. Introduction

The consensus opinion of most forest managers is that past management and fire suppression have increased the risk of atypical high-severity fires in the dry mixed-conifer and ponderosa pine (*Pinus ponderosa*) forest types (Arno et al., 1995; Hessburg et al., 2005). Therefore, the restoration of what are thought to be historical low-severity fire regimes and more fire-resilient forest structures has become the primary justification for fuel reduction and forest restoration treatments in ponderosa pine and mixed-conifer forest types throughout the western United States (Stephens et al., 2012). At the same time, however, there is a growing body of evidence that the high tree densities associated with some mixed-conifer forest types that are being thinned through restoration treatments are still well within the historical range of natural variation in stand structure (e.g., Sherriff and Veblen, 2007; Baker, 2009, 2012; Williams and Baker, 2012). Moreover, evidence that severe fire is not at all unusual but is, instead, an integral part of the historical, mixed-severity fire regimes common to most western mixed-conifer forests is also growing (Hutto, 2008; Hutto et al., 2008; Marlon et al., 2012; Baker, 2012; Williams and Baker, 2012; Heyerdahl et al., 2012; Odion et al., 2014). Nevertheless, the perception that stand conditions are unprecedented continues to motivate widespread forest restoration and fuel reduction efforts. In fact, recent legislation (e.g., Title IV of the Omnibus Public Land Management Act of 2009, which established the Collaborative Forest Landscape Restoration Program [CFLRP]) mandates such management on hundreds of thousands of hectares of federal forestland each year in the western United States.

Treatments designed to restore forest conditions directly manipulate forest structure and within-stand spatial patterns of mature trees. One recent study, for example, quantified changes in forest structure on several restoration treatment units in the Flathead National Forest, Montana, and confirmed that restored stands were indistinguishable from nearby reference stands, and that "thinning treatments were clearly successful at restoring the characteristic spatial structure of pre-suppression old-growth" (Larson et al., 2012, p. 1515). Several authors (e.g., Naficy et al., 2010; Hutto and Belote, 2013) have cautioned, however, that thinning treatments designed to restore old-growth forest conditions may achieve stated management goals in terms of forest structure, but may still fail to achieve desired ecological function.

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To address the concern that restoration of forest structure may not be accompanied by restoration of ecological function, we gathered pre-harvest and post-harvest data on bird abundance and community composition to gain a "bird's-eye view" of the effects of forest restoration treatments in the same stands where forest structure was reported to have been successfully restored (Larson et al., 2012). Birds represent a highly effective and useful ecological indicator group because large numbers of species can be detected using a single method (Hutto, 1998). More importantly, each species is associated with a distinct vegetation condition, and bird community structure is strongly influenced by, and sensitive to, forest structure (MacArthur and MacArthur, 1961). We predicted that if the untreated forest structure were unprecedented or beyond the historic natural range of variation, then bird community composition should also have been unprecedented, and restored forest stands should successfully emulate both the structure and function of dry, old-growth, mixed-conifer forests. Specifically, the bird community should respond to a restoration treatment, and the magnitude and direction of change in bird abundances after treatment should move bird community composition closer to that typical of dry, old-growth mixed-conifer, or at least of mesic, old-growth mixed-conifer forest stands that occur elsewhere in the region.

2. Methods

2.1. Study area

This study was conducted as part of the Meadow Smith old-growth restoration project on the Swan Lake Ranger District of Flathead National Forest near the town of Condon, Montana. Detailed, quantitative descriptions of forest structure before and after harvest were provided by Larson et al. (2012). Tree composition in treated and untreated control sites included western larch (*Larix occidentalis*), ponderosa pine, lodgepole pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmannii*), western redcedar (*Thuja plicata*), paper birch (*Betula papyrifera*), and trembling aspen (*Populus tremuloides*). Restoration treatment objectives were to promote open, large-tree-dominated stands of fire-resistant trees, especially ponderosa pine, western larch, and Douglas-fir; to maintain and improve vigor of trees that remained after harvest; and to maintain a stand structure that met minimum criteria associated with late-succession, old-growth conditions for western Montana Douglas-fir/western larch forests, as defined by Green et al. (1992). All ponderosa pine, western larch, western redcedar, and trembling aspen were designated for retention, as were all Douglas-fir >53.3 cm DBH. Lodgepole pine and small-diameter Douglas-fir, subalpine fir, and grand fir were prioritized for removal. The dense forest structure that characterized control and pre-treatment stands contrasted markedly with the more open structure of stands that had undergone restoration harvests (Fig. 1).

2.2. Study design

We used a Before–After/Control-Impact (BACI) analytical design to estimate the effects of restoration treatment on the relative abundances of the more commonly detected bird species. The Flathead National Forest and US Forest Service Regional Office oversaw the site selection, treatment prescriptions, and vegetation surveys, while the University of Montana Avian Science Center coordinated the collection of standard point-count data for birds in the treatment and nearby control stands. Treatment units varied in size from 2 to 34 ha (mean = 11.6 ha) and were interspersed with nearby control stands, some of which were slated for treatment in the future. Survey points were clustered within 8 different sites that included either control points only or both treatment and control points (Fig. 2). We classified the 8 sites as blocks for analysis to adjust for any spatial variation in abiotic conditions and disturbance history that might affect responses. Between 5 and 17 treatment and/or control points (Fig. 2) were located relatively uniformly, centrally, and at least 200 m from any other point within each site. Point location and classification data are provided in Appendix A.

Because some bird species have territories that exceed the sizes of most treatment plots, the treatment plots were smaller than ideal for assessing treatment effects. Nevertheless, point count data still reflect the probability of bird use in the immediate area surrounding each point, and are well suited to detect any change in the probability of use by a bird as a result of the harvests. If we hope to understand the ecological effects of treatments implemented by the US Forest Service, we have to use treatment plot sizes that are available for study.

To determine bird community composition in potential reference stands, we used data from point-count data collected in association with the Northern Region Landbird Monitoring Program (Hutto and Young, 2002). These data were collected using precisely the same method that we used to collect data for this study, but survey locations were broadly distributed across the USFS Northern Region in Idaho and Montana. We used count data to calculate the mean number of individuals of each bird species detected within 100 m during 10-min counts in each of five potential old-growth reference stand types. Stands were considered to be old growth if they were open-grown, uneven-aged, had snags present, and had 2–5 trees >40 cm dbh within 30 m of the survey point. The five potential old-growth reference stand types included: (1) ponderosa pine forest (59 points), where the dominant overstory canopy consisted of at least 80% ponderosa pine; (2) mature, dry, mixed-conifer forest (153 points), where the dominant overstory canopy consisted of between 20% and 80% ponderosa pine and Douglas-fir combined, with and small percentages of larch, Engelmann spruce, or lodgepole pine; and (3) mature mesic mixed-conifer forest (796 points), where the dominant overstory canopy consisted of less than 20% ponderosa pine and a mixture of other conifer species; (4) cedar–hemlock forest (303 points), where the dominant overstory canopy consisted of between 20% and 80% cedar and hemlock, and (5) subalpine forest (122 points), where most of the dominant overstory canopy consisted of a mixture of subalpine fir, lodgepole, spruce, and larch. All points were located at least 100 m from any other major vegetation type.

2.3. Bird surveys

Following a week-long training session for technicians, we conducted standard 10-min point counts to survey birds (Hutto et al., 1986; Ralph et al., 1995) between mid-May and mid-July in each of 5 years—3 years prior to treatment (2008–2010) and 2 years following treatment (2011 and 2012). We typically surveyed birds no earlier than 15 min after local sunrise and completed surveys by 11:00 am MST. At each point, a trained field technician recorded the distances to, and identities of, all birds detected by either sight or sound on each of two visits in all years of the study. We used 4 field technicians each year, and each was assigned randomly to a subset of points in a given year to minimize observer bias. In total, we surveyed 72 points between 2008 and 2012, including 24 at treatment sites and 48 at control sites; each point was surveyed in each of the 5 years. Survey points in potential reference stand conditions were surveyed between 1992 and 2008; in instances where a point was surveyed in more than one year, we randomly selected a year to include in the analysis.