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Breeding bird response to riparian forest management: 9 years post-harvest

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Abstract

We previously examined the 3-year response of breeding bird communities to timber harvest in riparian areas using two harvest techniques (full tree harvest (GPL) and cut-to-length (CTL)) along first- to third-order streams in northern Minnesota, USA. We revisited the same 12 sites 9 years post-harvest and compared community composition, total abundance, species richness, and the abundance of bird guilds on harvest plots randomly assigned to four treatments (three plots per treatment). Analyses revealed a significant response of the bird community to timber harvest in the riparian area. Nine years post-harvest, bird communities in the uncut riparian buffers were statistically indistinguishable from control bird communities. Differences in bird communities between CTL and GPL treatments detected 3 years post-harvest in buffers were no longer evident after 9 years. Breeding bird community composition in harvested buffers became more similar to uncut and control buffer communities in species composition. All treatment buffers continued to have more species and individuals than control buffers; these bird species had affinities for early-successional forests. No differences among forest interior species or ground-nesting birds were evident between treatments 9 years post-harvest.

Keywords: Breeding bird communities; Buffers; Cut-to-length; Forest; Harvest; Minnesota; Riparian; Principle response curves; Streams

1. Introduction

Protection of forest riparian areas for water quality and wildlife habitat during timber harvest with either fixed- or variable-width buffers has become a common management consideration in current forest practices. Most riparian management guidelines recommend set buffer widths and amounts of residual tree basal area required to protect or conserve riparian habitat function (Knopf, 1985). Buffer widths recommended to protect riparian forest function for wildlife habitat vary considerably across regions of North America and the majority of information available to suggest widths has been taken from short-term studies on response of wildlife to harvest (from 1 to 3 years post-harvest) (see Wegner, 1999). We are unaware of any forest harvest experiment study that has documented response of wildlife to riparian forest harvest for more than 3 years after the initial harvest.

We previously described breeding bird response to harvest and type of harvest technique used in riparian forests 3 years post-harvest (Hanowski et al., 2003). The harvest types used were the more traditional harvest method using whole-tree grapple skidding (GPL) and harvest with cut-to-length (CTL) harvest equipment. We examined response of breeding birds to the removal of basal area to an average of 7–10 m^2/ha. All experimental harvest sites were sampled again in 2006 and here we report on the longer time response of breeding birds to harvest equipment type and basal area remaining in riparian buffers.

2. Study area

We conducted the study along three tributary streams to Pokegama Lake (Pokegama Creek, Little Pokegama Creek, unnamed stream) in northern Minnesota (47′05″N latitude, 93′35″W longitude). More detailed description and diagram of the study area and methods can be found in Hanowski et al. (2003). Dominant tree species on plots were sugar maple (*Acer saccharum*), paper birch (*Betula papyrifera*), basswood (*Tilia americana*), and quaking aspen (*Populus tremuloides*). Streams

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were narrow (1–3 m wide), which is typical of first- to third-order streams in this region. This area was chosen because it had a forest cover at rotation age (about 80 years of age), the stream morphology was similar along all stream reaches, and the landowner was willing to harvest stands with the designated treatment. The individual study plots (12 total) were located along three separate streams within a 2-km^2 area (Hanowski et al., 2003). Study plots were 4.6 ha in size and were located along the streams such that the areas along the streams were separated from each other by at least 100 m. Biological independence, for example, assuring that the same individual was not recorded on more that one plot, was accomplished by separating the plots in space (Hanowski et al., 2003).

Study plots for the experiment were selected in the winter of 1996–1997. All experimental plots (9 total) were harvested in late-summer of 1997. Successional changes in vegetation were apparent among all treatment plots from 1997 to 2006 primarily in the adjacent upland harvest area. Edges of riparian harvest buffers were ''hard'' in 1998 but have become ''softer'' as the trees in the adjacent harvest area have grown. Upland treatment areas were open with short aspen regeneration in 1998 and in 2006, aspen trees exceeded 4 m in height. In addition, tree-fall within the riparian harvest area created pockets of downed woody material that was colonized by shrubby vegetation.

The experimental design consisted of a randomized block design. Treatment combinations consisted of one level of over-story manipulation combined with two types of harvesting operation, whole-tree harvest with grapple skidding and cut-to-length. Over-story treatments within riparian areas were designed to test best management practices (BMP) for water quality in Minnesota. This included leaving an average of 6–10 m^2/ha basal area within 30 m of either side of the stream. A block of uncut riparian control plots was retained in the experimental design as well as a total control (no harvest in the study plot). To accommodate the water quality and aquatic components of the study, treatments were assigned to plots randomly with the restriction that a riparian harvest plot was not immediately upstream of a control plot. Adjacent uplands (outside the 30 m riparian buffers) were clearcut to make them commercially operational and also representative of normal operating conditions.

2.1. Bird surveys

We conducted three breeding bird surveys on each plot in each year from 1997 to 2000 and again in 2006. Before-harvest data were collected on all plots in 1997 and post-harvest data were collected in 1998–2000 and 2006 (see Hanowski et al., 2003, for more detail). One survey was done in mid-May to document early breeding and permanent resident species (e.g., chickadees and woodpeckers), one in mid-June to capture peak singing of long-distance migrants, and one in early-July for the later breeding species (e.g., goldfinches). Because we were interested in documenting locations of birds relative to the stream, we used line-transects to conduct bird surveys. One line-transect (300 m in length) was placed through the middle of each plot perpendicular to the stream (Hanowski et al., 2003). Surveys were completed by four experienced observers who passed a bird identification test and a hearing test, and received training to standardize counts. All surveys were completed during early morning hours (within 4 h of sunrise) and with good weather conditions (no rain and winds <20 kph).

2.2. Data analyses

A sample was defined as three bird surveys on a transect in a year. For each sample ($n = 48$), we generated response (dependent) variables for individual bird species abundance and for bird community parameters. Because we were primarily interested in bird response to harvest in the buffers, we used only those birds observed within the designated riparian zone (30 m) on both sides of the stream. For each species, we used the maximum count of individuals observed on either the May, June, or July survey. We transformed all of our individual species maximum counts by $\ln(\text{count} + 0.2)$ for two reasons. First, we felt that a multiplicative model had more general utility for forest bird populations (McDonald et al., 2000), and second, to correct a violation of the normal distribution of errors assumption when the data were untransformed. For univariate community measures (species richness, total bird abundance) we used repeated-measures ANOVA models in SAS (SAS Institute, 2000). We included 1 year post-harvest (1997) and 4 years post-harvest data (1998, 1999, 2000 and 2006) in the analysis and used alpha level of 0.05 for determination of statistical significance.

We analyzed the response of riparian bird communities to harvest and harvest type using the multivariate principal response curves (PRCs) (Ter Braak and Smilauer, 1998; Kedwards et al., 1999a,b; Van den Brink and Ter Braak, 1999). We followed guidelines of Van den Brink and Ter Braak (1999), and Ter Braak and Smilauer (1998) to compute the first PRC. PRC is based upon *partial* redundancy analysis, a redundancy analysis in which explanatory variables are used to explain variation in bird species data set after first accounting for variation attributable to a third data set (covariable data). In other words, we first accounted for variation in species composition due to time, and then we attributed the remaining variation to the treatments. In our study, explanatory variables were 12 dummy variables that consisted of all combinations of the three non-control treatments and four post-treatment times. This set of explanatory variables is a subset of variables that were used in redundancy analysis (RDA) but excludes variables that denote control treatments or pre-treatment times. By excluding these variables, we ensured that treatment effects were expressed as deviations from the control (Ter Braak and Smilauer, 1998). Covariables were denoted by dummy variables indicating sampling year. The PRC was generated by plotting the first principle component of the treatment effects against time for each treatment group.

The significance of the PRC was assessed with a Monte Carlo permutation test, by permuting whole time series in the partial RDA from which the PRC was obtained. This test uses an F-type statistic based on the eigenvalue of the component (Ter Braak and Smilauer, 1998). The null hypothesis was that treatment effect was zero for all times, treatments, and guilds.