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Stewardship responsibility of Pennsylvania public and private lands for songbird conservation

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ABSTRACT

Preservation of large blocks of suitable habitat is an important conservation strategy for many species, and such protected areas often are publicly owned. In some cases, however, the extent of private land far exceeds that of public land, or species may prefer habitats that are predominantly privately owned (e.g., agricultural). Thus, it is important to understand the stewardship roles of both public and private land for species conservation. We used hierarchical multispecies occupancy models to evaluate the occurrence probabilities of 59 passerine bird species, including Species of Greatest Conservation Need, on public and private land in Pennsylvania, USA. Species strongly associated with forests disproportionately occupied public land, whereas grassland-associated species were strongly associated with private lands. Species associated with early-successional or shrub/edge habitat had more mixed responses. Our results emphasize that, despite the obvious importance of public land for some species, addressing habitat conservation on private lands is crucial for effective conservation of most passerine species, even in a region with extensive public land and for species strongly associated with public land.

1. Introduction

The value of protected natural areas for biodiversity conservation, ecosystem services, opportunities for tourism and recreation, scientific research and education, and as a source of renewable (and sometimes nonrenewable) resources, are widely recognized (Chape et al., 2008; Gray et al., 2016). In most cases, public lands provide more protection from development and other human activities than do private lands (USGS-GAP, 2012). Much of the public land in the USA is managed at least partially for the protection of biodiversity, and public lands often have greater biotic integrity than more developed or disturbed private lands (e.g., Glennon and Porter, 2005). For forest songbirds in the eastern USA, large publicly-owned forests and even small public parks in urban areas serve as critical migratory stopover locations (Mehlman et al., 2005). Despite the additional protection afforded public land, private land, including managed agricultural lands, also can provide crucial wildlife habitat and are integral to meeting conservation goals for many species. For example, much of the Prairie Pothole Region in North America is privately owned (USGS-GAP, 2012), but accounts for 50% to 80% of the reproduction of ducks in North America (Johnson et al., 2005). And, within a given landscape, species richness or abundance is not always greatest on public lands (Hansen and Rotella, 2002), and public protected lands may not capture all of the habitats important for biological diversity (Scott et al., 2001; Noss et al., 2002). To understand conservation needs of wildlife species and stewardship roles of public and private land, it is therefore important to understand the distribution and attributes of habitat and species occurrence across public and private land.

Within a region, the relative importance of public and private land for biodiversity conservation will depend on how much public and private lands differ in terms of landscape or land cover composition, on the relative quality and quantity of various habitat types in each ownership type, and on the habitat preferences of multiple species. The distribution of habitats may favor some species on private land and other species on public land. One ownership type may have better habitat than the other, but less of it, so that even though a species might be more likely to occur in the better habitat, that total abundance might be greater in the ownership type with the lesser habitat quality. Also, the total land area in public and private land varies regionally, with notably more public land in the western than in the eastern USA (USGS-GAP, 2012; Martinuzzi et al., 2015). In the eastern USA public lands are predominantly forested (USGS-GAP, 2012) and should therefore harbor

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communities of forest-obligate bird species, but fewer or sparser populations of grassland- or farmland nesting birds.

Even if some land cover features are similar across ownerships within a region, public and private lands may differ in other attributes, depending on landscape context, management history, or geologic conditions. For example, the proportion of forests in the landscape may be similar across ownerships, but public lands in some areas, particularly the mountainous regions of the USA, tend to be higher in elevation, and consequently have shallower or drier soils, and be less productive than private lands (Scott et al., 2001; Hansen and Rotella, 2002). Species richness often increases with land productivity (Verschuyl et al., 2008); however, more productive, lower-elevation private lands typically have a greater human footprint than higher-elevation public lands, and often favor human-associated bird species rather than area-sensitive species (i.e., species less likely to inhabit or persist in small habitat patches) that might be of greater management concern (Hansen and Rotella, 2002; Leu et al., 2008; Ribic et al., 2009). Given the same surrounding landscape context, land that is set aside from development often has greater species richness or biotic integrity than more developed land, both in a forested and agricultural context (Friesen et al., 1995; Van Buskirk and Willi, 2004; Glennon and Porter, 2005).

One way to assess the potential role or value of public and private land for species conservation is through multi-species gap analysis at a large scale (Scott et al., 1993), which overlays species distribution maps with relevant GIS layers to identify conservation hotspots or gaps in the context of land ownership or protected status of land. Because the large-scale systematic samples of species occurrences needed to model species distributions for such an analysis are rare, the proposed relative value of public and private land is driven by either the protected status of land or the proposed relationship of species to relevant habitat types and the distribution of those habitat types on the landscape. It would be preferable to build such predictions from appropriate samples of species occurrences. Songbirds are particularly well suited to this kind of species distribution mapping and landscape analysis because there are several large-scale datasets available for many species, including systematic long-term Breeding Bird Survey data (Sauer et al., 2014), intensive Breeding Bird Atlas snapshots in various states (e.g., Wilson et al., 2012), and more-or-less opportunistic, but widespread volunteer eBird data (Sullivan et al., 2009). La Sorte et al. (2015) used eBird data to show at a relatively coarse scale how stewardship responsibility for various bird species shifted between two management agencies (US Forest Service and Bureau of Land Management) during an annual cycle of breeding, migration, and wintering. The Breeding Bird Atlas project in Pennsylvania included systematic point counts conducted statewide by expert observers, and thus affords opportunity to examine occurrence on public and private lands at a fine scale.

In Pennsylvania and elsewhere there is considerable interest in conservation initiatives for certain species of conservation concern, and information about the relative importance of public and private lands for these and other species could help target efforts. For example, the Cerulean Warbler Conservation Initiative (Dawson et al., 2012) and the Golden-winged Warbler Working Group (Roth et al., 2012) are recent efforts that especially target habitat improvement on private lands. In this paper we evaluated stewardship roles of public and private lands throughout Pennsylvania, for a broad suite (59 species) of passerines associated with forested, early-successional, and grassland habitats, including numerous species of conservation concern within Pennsylvania and elsewhere. Pennsylvania has nearly 1.8 million ha of public land administered by various natural resource management agencies (approximately 15% of the state's total area), in a diverse landscape matrix ranging from highly developed to predominantly agriculture to extensive blocks of nearly contiguous forest. We used data from 33,763 roadside point counts to 1) estimate, for each species, the proportion of sites occupied that were located on public and private land; and 2) estimate a "public land" effect (a positive effect means that occurrence of a species is more likely at points on public than private land), after accounting for coarse land cover covariates that could explain some of the differences between public and private lands. We analyzed 4 non-mutually-exclusive groups of songbirds (Table A1) associated with either coniferous or mixed coniferous forests (CF), forest-interiors (FI), early successional or shrub/edge habitat (ES), and grassland habitat (GR). In Appendix B we also included a fifth group, comprised of passerine species listed as Species of Greatest Conservation Need in Pennsylvania's Wildlife Action Plan (Haffner and Day, 2015). Some of those species also were included in ≥ 1 of the other 4 groups (Appendix B, Table B1).

2. Methods

2.1. Study area and data

Our dataset included 33,763 roadside point counts conducted from 2004 to 2009 during a statewide Breeding Bird Atlas effort in Pennsylvania (PBBA). Point count locations were randomly selected within 4937 regional blocks corresponding to USGS 7.5-min quadrangles of approximately 24 km^2 (Wilson et al., 2012). Zero to 21 (median = 8) points were conducted in each block. Some blocks had fewer than 8 points either because low road density precluded additional roadside points, or because only a small portion of the quadrangle lay within Pennsylvania. Point count duration was 6.25 min, divided into 5 consecutive 75 s intervals. Each individual singing male was recorded during each interval in which it was heard (Wilson et al., 2012). Detections were binned by distance (≤ 75 m and > 75 m), but for this analysis we combined the 2 distance bins and used all detections. The majority of detections for most species were < 75 m and previous analysis indicates that nearly all detections were < 200 m (Wilson et al., 2012). Counts took place from 25 May to 4 July each year, beginning 30 min before sunrise and ending approximately 5 h later, but each point was surveyed only once, by one of 22 highly skilled observers. Blocks were randomly allocated by survey year, to ensure that there was no spatial bias to coverage among the atlas years.

Public ownership was determined by overlaying a shapefile of the sampling locations with a shapefile of publicly- owned land in Pennsylvania. We also used the 2006 National Land Cover Data (NLCD)[1] to quantify the proportion of various habitats (some of which we used as covariates in our model see below) in Pennsylvania and the proportion that is publicly-owned. We used the Landscape Fragmentation Tool v2.0[2] (Vogt et al., 2007; Hurd and Civco, 2010) extension for ArcGIS (ESRI, 2014) to define core forest as forest > 100 m from a forest edge. We defined forest cells as any NLCD cells classified as deciduous forest, coniferous forest, mixed forest, or woody wetlands; mixed conifer as coniferous or mixed forest; shrub as shrub/scrub; and grassland cells as any NLCD cells classified as grassland/herbaceous or pasture/hay.

Species groups were based primarily on literature species accounts, professional opinion, and conservation interest (Haffner and Day, 2015; Rodewald, 2015). We also based groups on previous exploratory analysis (Shoffner et al. in prep.) that used Kolmogorov–Smirnov tests to examine whether species were disproportionately associated with a high proportion of forest in landscapes (200 m up to 16 km radii) around point count locations, compared with a null model (found in proportion with forest cover). We intended the groups to be representative of species with certain habitat associations, but we recognize that the groups are not necessarily comprehensive, and we acknowledge lack of universal consensus about species groupings (Fraser et al., 2017).

[1] Available at http://www.mrlc.gov/nlcd06_data.php.

[2] Available at http://clear.uconn.edu/tools/lft/lft2/index.htm.