



Demographic response of a shrubland bird to habitat creation, succession, and disturbance in a dynamic landscape



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ABSTRACT

Shrubland birds have experienced widespread declines in the eastern United States. Habitat for shrubland birds is typically dynamic, in which available habitat changes temporally and spatially in response to disturbance and succession. Despite widespread concerns among conservationists about shrubland birds, much is still poorly understood regarding fundamental demographic processes associated with the persistence of species in dynamic landscapes, such as the age of colonists, their success upon establishment, the fate of birds displaced by disturbance, and the effect of displaced birds on neighboring territories. To address these knowledge gaps, we studied prairie warblers (*Setophaga discolor*) between 2008 and 2012 in a pitch pine-scrub oak (*Pinus rigida*–*Quercus ilicifolia*) barren consisting of newly created, maturing, and disturbed habitat patches. We found that newly created habitat patches were colonized primarily by younger, second-year males, whereas slightly older shrubland habitat was occupied by site-faithful older birds. Second-year males arrived later on the breeding grounds and had slightly lower pairing success compared to older males; however, they had similar reproductive output as older males. Based on mark-resight analyses, we calculated that 72% of adult males and 14% of banded nestlings returned to the study site in a following year. When territories were subject to high-intensity mowing, fire, or selective herbicide during the non-breeding season, only 14% of the males that returned to the study site stayed on their territories the following year. These returning males that acquired a territory within the study area had similar reproductive success to other birds in the study area and did not negatively affect the pairing or reproductive success of birds occupying adjacent areas. Disturbed territories made up a relatively small portion of the suitable habitat in the study area and disturbance affected a low number of territorial males in any given year. Overall, we found that the short-term effects of shrubland management and habitat disturbance on birds are minimal and subsequently allow young birds to colonize and breed. Moreover, the long-term effects of management are beneficial by maintaining ephemeral shrubland habitat for immigrating and site-faithful birds.

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1. Introduction

Disturbance-dependent ecosystems are characterized by spatial and temporal shifts in the age and distribution of habitat patches within the landscape over time. These ecosystems have been considered as having “patch dynamics” (White and Pickett, 1985), or as a “shifting mosaic” equilibrium (Watt, 1947). Whichever conceptual framework one adopts for a dynamic landscape, organisms that depend on early-successional, dynamic habitats are influenced by spatial and temporal shifts in habitat characteristics (Donner

et al., 2010; Fuhlendorf and Engle, 2004; Lent and Capen, 1995). For example, shrubland birds colonize recently disturbed habitat and change in abundance as habitat suitability changes with succession, ultimately becoming locally extirpated as the habitat reverts to older forest (DeGraaf and Yamasaki, 2003; Schlossberg and King, 2009).

Despite the attention that has been directed at understanding the habitat requirements of early-successional species (e.g. Greenberg et al., 2011; Thompson and DeGraaf, 2001), even the most basic demographic processes that influence populations of shrubland species in dynamic habitats remain poorly understood. For example, the sequence in which different bird species colonize shrubland habitats has been understood for decades (Johnston and Odum, 1956); however, whether birds colonizing new habitat

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originate from within the local area or from populations within a larger landscape is largely unknown (Dale et al., 2006; Lehnen and Rodewald, 2009). Furthermore, the success of management efforts should include consideration of reproductive success (Sallabanks et al., 2000), but the rate at which newly created habitats become productive after disturbance is not understood. Schlossberg (2009) proposed that newly created habitat would be colonized by young males returning for their first breeding season (“second year” or “SY” males), as SY birds exhibit low natal philopatry (Greenwood and Harvey, 1982; Lehnen and Rodewald, 2009) and would be more inclined to disperse and find newly created habitat. Older males (“after second year” or “ASY” males) may exhibit higher site fidelity in existing habitat (Schlossberg, 2009; Donner et al., 2010) and be less likely to colonize new habitat. Given younger birds may be more abundant in newly created habitats, these habitats could have lower productivity because young birds can experience reduced reproductive success (Nol and Smith, 1987; Nolan, 1978). Newly created shrubland habitats also tend to have poorly developed vegetation structure (Chandler et al., 2009; Smetzer et al., 2014), which could negatively affect nest concealment and reproductive success.

In addition, it is important to consider the implications of shrubland habitat management or other natural disturbances on individuals occupying areas prior to disturbance. Birds may disperse to adjacent habitat the breeding season after disturbance (Brotons et al., 2005; Darveau et al., 1995; Schmiegelow et al., 1997), have delayed dispersal, or remain in the habitat after disturbance (Chandler, 2006; Weins and Rotenberry, 1985). Only a few studies have tracked individually marked birds following a disturbance. Betts et al. (2006) observed dispersal of two color-banded mature forest birds that each dispersed over 1 km following timber harvest. Rousseau et al. (2012) observed that 50% of 14 color-banded male white-throated sparrows (*Zonotrichia albicollis*) dispersed over 100 m after most of their forested territories were clear-cut. If individuals disperse after disturbance, this can affect birds in adjacent areas. For example, Hagan et al. (1996) found an increase in forest birds in adjacent, non-disturbed habitat following the disturbance of forest sites by logging, which resulted in decreased pairing success in adjacent habitat, perhaps as a result of crowding. Few studies have examined if this also occurs with shrubland birds, despite disturbance such as mowing, fire, and herbicide treatments being used regularly as part of habitat maintenance for these species.

Understanding the demographic processes underlying patterns of colonization and persistence within dynamic landscapes is important because early-successional habitats and associated species are declining dramatically in the eastern United States and elsewhere (Litvaitis, 1993; Preiss et al., 1997; Trani et al., 2001), representing a critical conservation challenge (Oehler, 2003). To address these knowledge gaps, we studied prairie warblers (*Setophaga discolor*), a Neotropical migratory shrubland bird species, in a managed, inland pitch pine-scrub oak (*Pinus rigida*–*Quercus ilicifolia*) barren consisting of newly created, maturing, and disturbed shrubland habitats. Specifically, we estimated prairie warbler demographic parameters (abundance, age structure, arrival dates, reproductive output, site fidelity, and territory fidelity) as a function of habitat disturbance and succession to determine how shrubland birds respond to the changing habitat conditions that comprised this dynamic landscape. Since the purpose of shrubland habitat management is to support populations of shrubland-dependent species, including birds, detailed knowledge of how these populations are affected by the habitat disturbance and succession associated with management practices is fundamental to understanding the degree to which management activities achieve their intended effects.

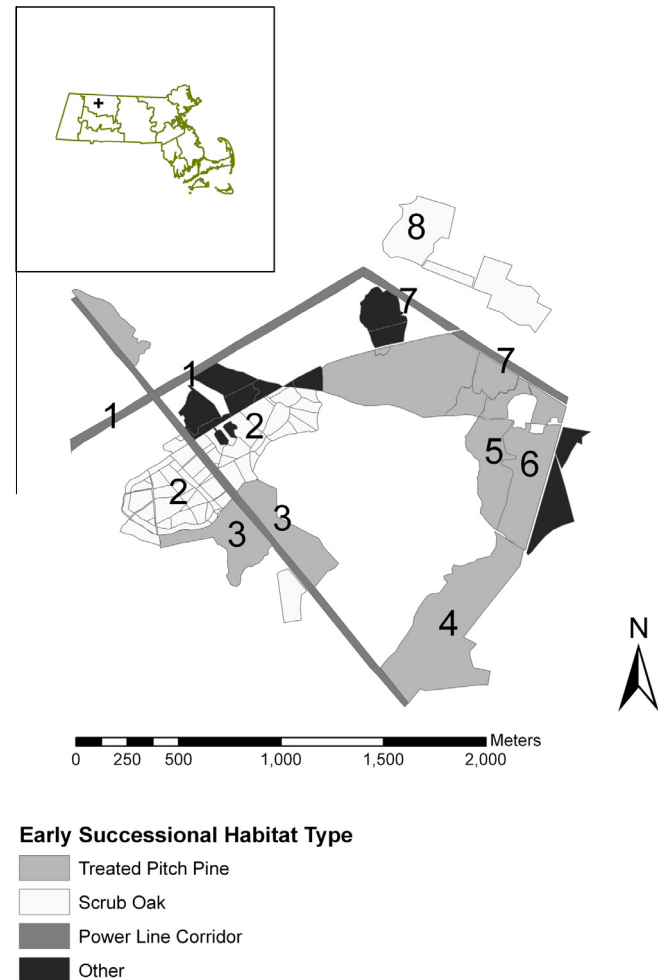


Fig. 1. Map of the MPWMA, located in Montague, MA (inset map of Massachusetts, USA). Numbers indicate plots used in the study. Plot 2 consisted of many smaller treatment patches within the plot. Unmarked, white sections in the study site (i.e., the center area) consist of mostly mature pitch pine and deciduous closed canopy forest. Early-successional habitat types classified as “other” include sand pits or areas with some shrubby understory but with more (>50%) canopy cover.

2. Methods

2.1. Study site

The study took place from 2008 to 2012 on the Montague Plains Wildlife Management Area (MPWMA), a 607 ha, actively managed pitch pine-scrub oak barren located in Western Massachusetts, U.S.A. (N42°34', W72°31'). The MPWMA, like most pitch pine-scrub oak barrens, encompasses plant communities that are highly flammable and naturally adapted to frequent fires (Motzkin et al., 1999). In 2000, the Massachusetts Division of Fisheries and Wildlife started a program of habitat restoration and fuels reduction to reduce wildfire risk and promote biodiversity. This was accomplished by thinning pitch pine stands to 25% residual canopy cover and treating scrub-oak stands with mowing and prescribed fire (King et al., 2011). We sampled birds in scrub oak barrens (2 plots; 28.7 and 6 ha), treated pitch pine (4 plots; 15.1, 22.5, 7.8 and 10.8 ha), and power line corridors (2 plots; 4.2, 5.7 ha), which comprised most of the early-successional area and the principal habitats occupied by prairie warblers within this pitch pine-scrub oak barren (King et al., 2011; Fig. 1). Plots were similar in terms of elevation, topography, and overall vegetation community. Scrub oak

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