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Multiscale habitat selection by a forest-dwelling shorebird, the American woodcock: Implications for forest management in southern New England, USA

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ABSTRACT

Declines of young forest and associated populations of wildlife are major conservation concerns in the Northeast, USA. Active forest management is required to conserve declining populations of young forest wildlife and investigating habitat selection by target species can help inform management decision-making. The American woodcock (*Scolopax minor*) is a key indicator species of young forest whose populations have declined significantly since 1968. We investigated multiscale habitat selection by woodcock in Rhode Island, USA in order to characterize daytime habitat, and to predict state-wide relative probability of use by woodcock of forested land. We used radio-telemetry to monitor the daytime locations of woodcock at three state wildlife management areas from 23 May–25 August 2011 and 2012. Compared to random sites, woodcock selected younger forest where the biomass of preferred food (i.e., earthworms [Haplotaxida]) was 46–67% greater and the density of shrub and sapling stems was about two times greater. Most woodcock home ranges were <50 ha and usually comprised wetland forests and deciduous or mixed upland forests on flatter slopes that were closer to streams, agricultural openings, upland young forests, and moist soils. Using resource selection functions, we found that the majority of forested land in Rhode Island was in the low-moderate classes of relative use, but 92% of older second-growth upland forest in the state is located where woodcock habitat management would be beneficial for increasing relative use. We illustrate how land managers can use resource selection functions to compare expected responses of woodcock to alternative forest management scenarios and so maximize conservation benefits.

1. Introduction

Reduced extent of early-successional forest and shrubland vegetation types (hereafter young forest) in the Northeast, USA, over the last 60 years has caused declines in populations of wildlife that depend on young forest (Askins, 2001; DeGraaf and Yamasaki, 2003; Dettmers, 2003; Trani et al., 2001). Historically, natural disturbance regimes such as wind, fire, and ice storms, and biological agents including insects, pathogens, beavers (*Castor canadensis*), and Native Americans sustained patchworks of young forest (Askins, 2001; Day, 1953; Foster and Aber, 2004; Lorimer, 2001). Prior to European settlement, young forest may have occupied up to 13% of the land area in some regions of eastern North America (Lorimer, 2001), but following European settlement, intensive logging and conversion of land from forest to agriculture formed a largely non-forested landscape which eventually produced an influx of young forest across the Northeast. Indeed, in central New England, USA, >75% of remaining forests were <30 years old during the late-1800s (Foster et al., 1998). However, since the 1960s, the amount of young forest in the region declined from about 30–35% to ⩽3% (Buffum et al., 2011; Trani et al., 2001). Consequently, active forest management is now required to conserve populations of young forest wildlife (DeGraaf and Yamasaki, 2003; Schlossberg and King, 2007), and habitat selection by target species should be investigated using quantitative methods to promote more informed and efficient forest management decision-making.

Classical approaches to investigating habitat selection involve comparing attributes of habitat or food measured at sites used by target species and sites unused by or available to target species (Johnson, 1980; Manly et al., 2002). For example, studies comparing vegetation structure at nest or roost sites and random sites

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using traditional null hypothesis testing help describe habitat features associated with reproduction or occupancy for forest birds (e.g., McAuley et al., 1996; Miller and Jordan, 2011; Zahner et al., 2012) and mammals (e.g., Hackett and Pagels, 2003; O'Keefe et al., 2009). More recently, studies of habitat selection have transitioned towards using resource selection functions (RSFs) to understand how probability of use by target species is influenced by environmental covariates (Johnson et al., 2006; Manly et al., 2002; McDonald, 2013). Importantly, these analysis methods allow multiple competing hypotheses to be easily tested using an information-theoretic approach (Anderson et al., 2000; Johnson et al., 2006), facilitate studies of habitat selection across multiple spatial scales (e.g., Johnson et al., 2004), and can be used to predict shifts in probability of use by target species in response to environmental change (e.g., Brown et al., 2007). We investigated habitat selection by American woodcock (*Scolopax minor*) using both traditional and contemporary analysis methods in order to inform young forest management in the Northeast.

The American woodcock (hereafter woodcock) is a key indicator species of young forest because populations thrive only in landscapes with an appropriate mixture of young forest ranging from forest openings to approximately 30-year-old forest stands (Kelley et al., 2008). Woodcock breed across the eastern USA and adjacent southern and southeastern Canada and winter mainly across the southern half of the eastern USA (Sheldon, 1967), and their populations have declined significantly since 1968 (Cooper and Rau, 2012). Although woodcock are a popular game bird, woodcock survival is similar between hunted and non-hunted sites so recreational hunting is not believed to be contributing to observed population declines (McAuley et al., 2005). Instead, loss and degradation of preferred young forest is the principal factor driving population declines (Dessecker and McAuley, 2001; Kelley et al., 2008; McAuley et al., 2005). High densities of small tree and shrub or sapling stems characteristic of young forests provide protective cover from diurnal predators (Dessecker and McAuley, 2001; Keppie and Whiting, 1994; McAuley et al., 1996; Straw et al., 1986) whereas recent forest clearcuts, maintained or abandoned agricultural fields, tree plantations, and other forest openings provide critical breeding areas during spring crepuscular periods (Sheldon, 1967), safe roosting areas during summer nights (Dunford and Owen, 1973; Masse et al., 2013), and feeding or roosting areas during fall and winter nights (Blackman et al., 2012; Connors and Doerr, 1982; Krohn et al., 1977).

In this study, we investigated habitat selection by woodcock in important state-owned wildlife management areas in Rhode Island, USA, where young forest was limited, but actively being created. Young forest occupies only 3% of the land area in Rhode Island (Buffum et al., 2011) and an estimated 377 km^2 of new young forest is needed to restore woodcock densities (Kelley et al., 2008). Our objectives were to (1) characterize the daytime habitat selected by woodcock, (2) predict and map the relative probability of use by woodcock of forested land across Rhode Island, and (3) illustrate how land managers can forecast how forest management practices aimed at creating woodcock habitat influence relative use of the surrounding landscape. Addressing these objectives will increase knowledge of woodcock habitat selection in areas where preferred young forest is uncommon and permit more informed forest management decision-making. We predicted that woodcock would select areas of younger forest where preferred food (i.e., earthworms [Haplotaxida]) and shrub or sapling stems were more abundant, and that creating upland young forest and forest openings via forest clearcutting at sites deemed most beneficial for woodcock habitat management would increase relative use of the surrounding landscape.

2. Methods

2.1. Study area

We investigated woodcock habitat selection in three state wildlife management areas (Arcadia, Big River, and Great Swamp) in Kent and Washington Counties, Rhode Island. Each management area was dominated by forested cover types although the relative proportions of each differed among sites (RIGIS, 2012). Arcadia (41°35′10″N, 71°43′20″W) was 62 km^2 of which deciduous (33%), mixed (31%), and coniferous upland forest types (24%) predominated, while wetland forest types (7%) were uncommon. Big River (41°37′0″N, 71°36′60″W) was 33 km^2 and comprised deciduous (8%), mixed (31%), and coniferous upland forest types (45%), while wetland forest types (6%) were scarce. In contrast, Great Swamp (41°27′15″N, 71°35′19″W) was 15 km^2 and composed of deciduous (16%), mixed (5%), and coniferous upland forest types (1%), while wetland forest types (55%) were common. Mixed oaks (*Quercus* spp.), hickories (*Carya* spp.), and red maple (*Acer rubrum*) dominated deciduous upland forest types while coniferous and mixed upland forest types were dominated by Eastern white pine (*Pinus strobus*) and oaks and pines, respectively (Enser and Lundgren, 2006). Red maple swamps were the most widespread wetland forest type and Atlantic white cedar (*Chamaecyparis thyoides*) swamps occurred locally (Enser and Lundgren, 2006).

During 1995, the Rhode Island Department of Environmental Management initiated a forest cutting program to benefit declining populations of woodcock and other wildlife associated with young forest. A series of 2–5-ha clearcuts in older second-growth forest (e.g., 60–100 years) were initially made at Great Swamp followed by additional forest management at that site during 2007 and 2012. Similar forest management began at Arcadia and Big River during 1996 and 2006, respectively. Future management at each site is expected to involve additional forest cutting at regular (e.g., 10-year) intervals and, where appropriate, the creation of larger (e.g., 10-ha) young forest patches. At the time of this study, Great Swamp contained the highest proportion of combined upland and wetland young forest (15%) whereas young forest was uncommon at Arcadia (2%) and Big River (1%). Forest openings in the form of abandoned meadows and agricultural fields were also maintained to benefit woodcock and other wildlife, but the relative proportions of these at each site were low (i.e., 1–2%).

2.2. Woodcock capture, marking, and tracking

We caught woodcock from 2 April–16 May 2011 and 2012 (IACUC protocol AN10-02-017) by placing mist-nets at known singing grounds where males engaged in crepuscular courtship displays to attract females for breeding (McAuley et al., 1993; Sheldon, 1967). We included only male woodcock in our study because females are difficult to catch with mist-nets during spring (McAuley et al., 1993). We caught 50 males during 2011 and 42 males during 2012, and determined age by examining plumage characteristics of wings (Sheldon, 1967). After capture, we fitted each woodcock with an Advanced Telemetry Systems 2-stage transmitter (Model A5400) using cattle tag cement and a wire belly-band for attachment (package weight ⩽4.0 g; McAuley et al., 1993) and released birds on site.

From 23 May–25 August 2011 and 2012, we monitored the daytime locations of each bird 3–4 times per week. We tracked radio-marked birds on foot using a 3-element antenna and approached each bird until the receiver gave an audible signal without the use of the antenna or headphones. On average, this method allowed us to approach to ⩽18 m (Masse et al., 2013) and we marked exact locations in the field using a handheld GPS unit.