

See discussions, stats, and author profiles for this publication at: <http://www.researchgate.net/publication/281059883>

Higher bird abundance and diversity where American woodcock sing: Fringe benefits of managing forests for woodcock

ARTICLE *in* JOURNAL OF WILDLIFE MANAGEMENT · AUGUST 2015

Impact Factor: 1.73 · DOI: 10.1002/jwmg.945

DOWNLOADS

9

VIEWS

14

3 AUTHORS:



Roger J. Masse

Stephen F. Austin State University

7 PUBLICATIONS 7 CITATIONS

SEE PROFILE



Brian Tefft

Rhode Island Government

14 PUBLICATIONS 69 CITATIONS

SEE PROFILE



Scott R McWilliams

University of Rhode Island

114 PUBLICATIONS 1,361 CITATIONS

SEE PROFILE



Note

Higher Bird Abundance and Diversity Where American Woodcock Sing: Fringe Benefits of Managing Forests for Woodcock

ROGER J. MASSE,^{1,2} *Department of Natural Resources Science, University of Rhode Island, 102 Coastal Institute in Kingston, Kingston, RI 02881, USA*

BRIAN C. TEFFT, *Rhode Island Department of Environmental Management, Division of Fish and Wildlife, 277 Great Neck Road, West Kingston, RI 02892, USA*

SCOTT R. MCWILLIAMS, *Department of Natural Resources Science, University of Rhode Island, 102 Coastal Institute in Kingston, Kingston, RI 02881, USA*

ABSTRACT Declines of early-successional forest across the northeast United States during the past 60 years has caused declines in populations of associated birds and active forest management is necessary to reverse these trends. Land managers often focus on a few target species with hopes that non-target species are also conserved, but the effectiveness of management for so-called umbrella species is seldom verified. We compared bird assemblages at American woodcock (*Scolopax minor*) singing grounds and nearby, random forest sites to determine whether habitat management for woodcock benefits non-target bird species. Early-successional forest species were a key component of bird assemblages at singing grounds, but were largely absent from random forest sites. On average, the total number and diversity of birds were ≥ 1.5 times greater at singing grounds. We also found evidence for broader landscape differences in the number of bird species expected at singing grounds ($n = 48$; 95% CI = 41–56) and random forest sites ($n = 34$; 95% CI = 28–41). Our results indicate that forest management to support woodcock populations extends some conservation benefits to diverse non-target bird species. Thus, the woodcock may serve as an effective umbrella species, especially for early-successional forest birds, but complementary umbrella species should be considered to aid in the conservation of birds that breed in more mature forest. © 2015 The Wildlife Society.

KEY WORDS American woodcock, clearcut, early-successional forest, *Scolopax minor*, singing ground, umbrella species.

Declines of early-successional forest and populations of associated birds are important management concerns in the northeast United States (Dettmers 2003, Buffum et al. 2011). Conservation planning to support early-successional forest birds requires active forest management because historical natural and biological disturbances have been unable to maintain stable populations on contemporary landscapes (DeGraaf and Yamasaki 2003, Schlossberg and King 2007). Conservation planning that requires active habitat management is complicated because not all species can be managed for simultaneously. Wildlife managers must often set priorities with limited resources and may simplify conservation planning by focusing management on a single or few target species in hopes of maximizing conservation

benefits (Noss 1990, Lambeck 1997, Simberloff 1998). Umbrella species represent one potential management target and these are usually depicted as large-bodied, wide-ranging species with vast area requirements (Noss 1990, Caro and O'Doherty 1999). More generally, umbrella species are simply those whose conservation works to conserve diverse populations of sympatric non-target wildlife (Fleishman et al. 2000).

The effectiveness of managing for umbrella species has been debated (Simberloff 1998, Andelman and Fagan 2000, Sattler et al. 2014) because managing for some potential umbrella species enhances diversity and abundance of non-target species (e.g., Siberian flying squirrel [*Pteromys volans*]; Hurme et al. 2008), whereas managing for others may not (e.g., greater sage-grouse [*Centrocercus urophasianus*]; Rowland et al. 2006). For example, species richness and abundance of key forest-breeding birds were higher near western capercaillie (*Tetrao urogallus*) leks so Finnish managers targeting western capercaillie also help to conserve regionally important non-target forest birds (Pakkala et al. 2003). Prospective umbrella species may share certain

Received: 24 January 2015; Accepted: 5 July 2015

¹E-mail: masserj@sfasu.edu

²Present address: Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, 419 E. College Street, P.O. Box 6109 SFA Station, Nacogdoches, TX 75962, USA

inherent characteristics (Caro and O'Doherty 1999), but the co-occurrence of diverse non-target species is necessary if umbrella species are to effectively maximize conservation benefits (Fleishman et al. 2000). Accordingly, verification that managing for putative umbrella species extends conservation benefits to diverse non-target species should be required before the use of these conservation shortcuts is advocated.

The American woodcock (*Scolopax minor*; hereafter woodcock) is a prospective umbrella species for early-successional forest birds because woodcock populations require diverse vegetation types ranging from 30-year-old forest stands to early-successional forest openings (Kelley et al. 2008). Moreover, woodcock populations decline without the appropriate spectrum and spatial configuration of preferred vegetation types (Dessecker and McAuley 2001, McAuley et al. 2005). Indeed, long-term monitoring suggests that woodcock populations have declined by about 1% per year since 1968 (Cooper and Rau 2013). Woodcock are also popular game birds (Cooper and Rau 2013); therefore, diverse stakeholders including federal or state wildlife agencies, non-governmental organizations (e.g., Ruffed Grouse Society), and certain private landowners may be concerned with maintaining harvestable populations. Importantly, active forest management is required to provide the necessary vegetation types to support woodcock populations on contemporary landscapes (Kelley et al. 2008, Williamson 2010). Diverse non-target wildlife may simultaneously benefit from vegetation types managed for woodcock populations (Wildlife Management Institute 2014), but empirical evidence supporting this idea has yet to be published.

Early-successional forest openings such as recently harvested or mowed clearcuts, maintained or abandoned agricultural fields, and wildlife openings are necessary components of woodcock habitat because these singing grounds are where males engage in crepuscular courtship displays to attract females for breeding (Sheldon 1967). We compared the relative abundance and diversity of bird species at singing grounds in managed, early-successional forest openings versus nearby, random forest sites. If woodcock represent a potential umbrella species then the relative abundance and diversity of non-target birds will be greater at singing grounds.

STUDY AREA

We conducted this study at 3 forest-dominated wildlife management areas (Arcadia, Big River, and Great Swamp) in Kent and Washington Counties, Rhode Island, USA. Arcadia (41°35'10"N, 71°43'20"W) was 62 km² comprised mostly of upland forest types (88%), whereas wetland forest types (7%) were uncommon. Big River (41°37'0"N, 71°36'60"W) was 33 km² also comprised mostly of upland forest types (84%) and wetland forest types (6%) were infrequent. Great Swamp (41°27'15"N, 71°35'19"W) was 15 km² of which upland forest types (22%) were less common and wetland forest types (55%) predominated (Rhode Island Geographic Information System 2012). Coniferous upland forests in the region were dominated

by eastern white pine (*Pinus strobus*) or a mix of eastern white pine and pitch pine (*Pinus rigida*), mixed upland forests typically contained these species along with various oaks (*Quercus* spp.), and deciduous upland forests were dominated by red maple (*Acer rubrum*), hickories (*Carya* spp.), and oaks (Enser and Lundgren 2006). Red maple swamps were the typical wetland forest type in the region (Enser and Lundgren 2006).

At each study area, the Rhode Island Department of Environmental Management maintained early-successional forest openings and patches of early-successional forest by periodically clearcutting areas of older, secondary upland forest (e.g., 60–100 yrs old) to support populations of woodcock. In many forest openings and clearcuts, woody regeneration was dominated by coppice growth from former canopy trees (e.g., red maple or oaks), whereas invasive shrubs including glossy buckthorn (*Frangula alnus*) and autumn olive (*Elaeagnus umbellata*) were dominant in others. Portions of forest openings and recently harvested clearcuts were also mowed annually to maintain the open ground structure necessary for woodcock singing grounds and control of invasive shrubs. A series of 2–5-ha clearcuts were first managed at Great Swamp, Arcadia, and Big River during 1995, 1996, and 2006, respectively. During 2007, additional clearcuts were managed at Great Swamp and a long-term early-successional forest management plan was adopted, which, with support from the Wildlife Management Institute, helped designate a section of Great Swamp as a Woodcock Habitat Demonstration Area during 2008. Given recent habitat management, the proportion of early-successional forest was highest at Great Swamp (15%) followed by Arcadia (2%) and Big River (1%). Maintained or abandoned agricultural fields and other herb-dominated forest openings comprised 1–2% of each study area.

METHODS

Point Count Surveys

We used standard 10-minute, 50-m radius point count surveys (Ralph et al. 1993) to determine the relative abundance and diversity of bird species at singing grounds and random forest sites. We did not measure distance to detected individuals because auditory detections predominate in forest cover types (DeJong and Emlen 1985) and distance measurements based on auditory detections are inaccurate beyond 65 m (Alldredge et al. 2007a). Thus, we constrained our point count surveys to 50-m fixed-radius plots, which are sufficient for estimating indices such as relative abundance (Ralph et al. 1993, Pierce et al. 2012). We identified singing grounds from 2 April to 19 May 2011–2013 at Arcadia and Great Swamp, and 2012–2013 at Big River, as part of a separate study investigating woodcock habitat selection in the region (Masse et al. 2014). During evening crepuscular periods, from sunset to approximately 1 hour after sunset, 1–5 observers scouted sections of each study area by watching 2–3 courtship flights of displaying male woodcock and marking exact locations of singing grounds with surveyor flagging. Each spring, we

identified 15–20 singing grounds at Arcadia, 14 at Big River, and 10–13 at Great Swamp. Singing grounds were generally located within ≤ 7 -year-old clearcuts or maintained wildlife openings, but some were located within abandoned meadows or near the margins of agricultural fields.

The quality of surrounding habitat for nesting and brood rearing by female woodcock likely influences singing ground use (Dessecker and McAuley 2001) so some singing grounds at each study area were clustered near sites where nesting habitat was concentrated. For this study, we included a random subset of 9 singing grounds at Arcadia and Great Swamp during 2011 and 10 singing grounds at each study area during 2012–2013 that were ≥ 200 m apart to promote independence. If the same singing grounds were used during successive years then we retained those sites in our sample and revisited them each year. Otherwise, we randomly selected new singing grounds for inclusion provided they met our minimum distance criteria. From 2011 to 2013, we surveyed 15 singing grounds at Arcadia (40% sampled 1 yr; 27% sampled 2 yrs; 33% sampled 3 yrs) and 13 singing grounds at Great Swamp (23% sampled 1 yr; 31% sampled 2 yrs; 46% sampled 3 yrs). From 2012 to 2013, we surveyed 15 singing grounds at Big River (67% sampled 1 yr; 33% sampled 2 yrs). At each study area, we generated a simple random sample of 10 points to survey in forested cover types that were ≥ 200 m from each other and from the singing grounds included in this study using ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, CA, USA) and revisited these sites each year.

From 27 May to 2 July, we conducted 1 point count survey per year at each singing ground and random forest site from 0510 to 1045 hours during mornings with calm wind and no rain. To eliminate potential bias from differences in observer ability (Alldredge et al. 2007b), the same experienced observer conducted all surveys. We navigated to point count locations on foot and conducted 4–6 surveys during a given morning. We alternated the timing of point count surveys at singing grounds and random forest sites to ensure that surveys at both sites were conducted at various times throughout the morning period. We identified bird species and counted the number of individuals seen or heard within 50 m of each point count location, and excluded fly-by species that were observed above the height of the surrounding canopy.

Statistical Analysis

We determined the frequency of occurrence for all species detected and calculated mean relative abundances for the 3 most common species at singing grounds and random forest sites across point counts at each study area and for each year. We counted the total number of birds (all species combined) and estimated the diversity of birds by calculating the Shannon–Weiner Index (H' ; Magurran 2004) and converting to Diversity (D ; Jost 2006) for each point count location. We used a linear mixed model to test the main effects of site (i.e., singing ground vs. random forest), study area, year, and all interactions on the number and diversity of birds. We specified a random intercept corresponding to point count

location to account for repeated surveys and we used the Gauss–Hermite quadrature approximation method to obtain maximum likelihood estimation (SAS Institute, Inc., Cary, NC, USA). We assumed a normal distribution because Shapiro–Wilk tests (Shapiro and Wilk 1965) and normal probability plots suggested the number and diversity of birds were normally distributed, and we adjusted for multiple comparisons using the Tukey–Kramer method (Kramer 1956). For each dependent variable, we ran a separate model for Arcadia and Great Swamp during 2011–2013 and for all study areas during 2012–2013 because the former provided the strongest test for annual differences, whereas the latter provided the strongest test for site differences.

We used sample-based rarefaction (Colwell et al. 2004) to generate species accumulation curves for singing grounds and random forest sites across study areas to examine differences in species richness throughout southern Rhode Island. Singing grounds that were surveyed during only 1 year were automatically included in this analysis. For singing grounds that were surveyed during 2–3 years, we randomly selected 1 year to include so that each point count location in this analysis was independent and represented by equal sampling effort. Likewise, we randomly selected 1 year to include for each random forest site. In total, we included 43 point count surveys at singing grounds and 30 at random forest sites. We used the program EstimateS 9.1.0 (EstimateS 9.1.0, www.purl.oclc.org/estimates, accessed 8 Jan 2014) to extrapolate rarefaction curves to 50 point count surveys and assessed differences in the expected number of species by examining the overlap of 95% confidence intervals (Colwell et al. 2012).

RESULTS

Cedar waxwing (*Bombicilla cedrorum*), chipping sparrow (*Spizella passerina*), common yellowthroat (*Geothlypis trichas*), gray catbird (*Dumetella carolinensis*), prairie warbler (*Setophaga discolor*), and yellow warbler (*Setophaga petechia*) occurred most frequently at singing grounds. Most of these (5 of 6) were early-successional forest species (Fig. 1). In contrast, black-and-white warbler (*Mniotilta varia*), black-capped chickadee (*Poecile atricapillus*), northern waterthrush (*Parkesia noveboracensis*), ovenbird (*Seiurus aurocapilla*), pine warbler (*Setophaga pinus*), red-eyed vireo (*Vireo olivaceus*), and veery (*Catharus fuscescens*) occurred most frequently at random forest sites, and of these, black-and-white warbler was the sole early-successional forest species. At each study area, the relative abundances of the most frequently occurring species were dissimilar. Early-successional forest species were typically more abundant at singing grounds and scarce or absent at random forest sites, whereas the opposite was generally true for species typical of more mature forest (Fig. 1).

The total number and diversity of birds per 50-m plot were highly correlated at each study area ($r \geq 0.86$). During 2011–2013, the number of birds (mean \pm SE) was nearly 2 times greater at singing grounds (7.53 ± 0.38) than random forest sites (3.82 ± 0.38 ; $F_{1, 68} = 47.40$, $P < 0.001$). Similarly, the diversity of birds (mean \pm SE) was 1.6 times greater at singing grounds (4.81 ± 0.23) than random forest sites (3.01 ± 0.23 ; $F_{1, 68} = 29.63$, $P < 0.001$). Both the number

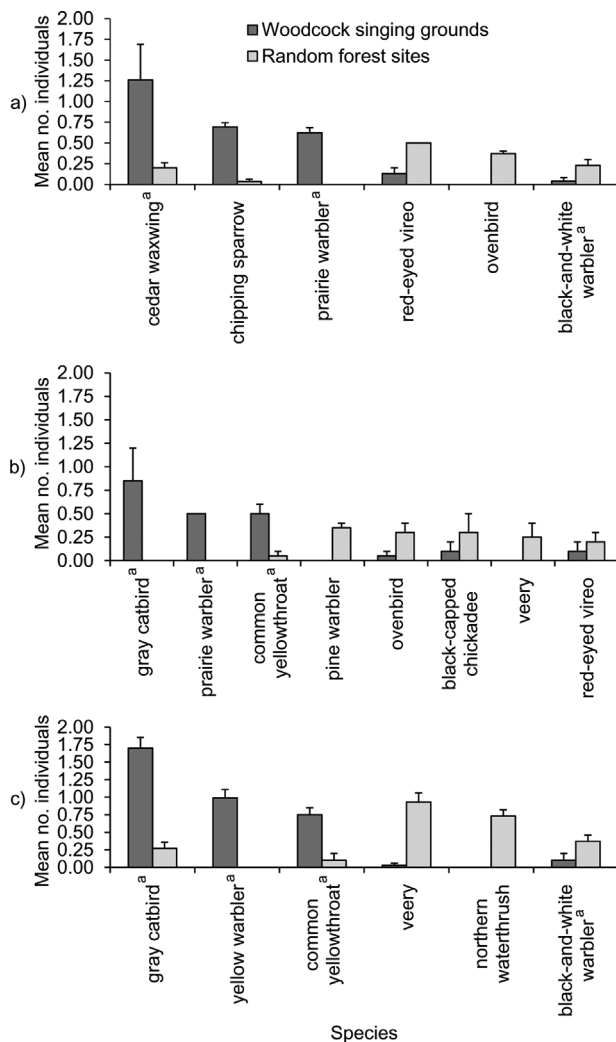


Figure 1. Mean relative abundance per 50-m plot for the bird species observed with the 3 highest frequencies of occurrence at woodcock singing grounds and nearby random forest sites during 10-minute point count surveys conducted from 27 May to 2 July 2011–2013 at Arcadia (a), 2012–2013 at Big River (b), and 2011–2013 at Great Swamp (c) Wildlife Management Areas in Kent and Washington Counties, Rhode Island, USA. The highest frequencies of occurrence were identical for some species at random forest sites at Big River so 2 additional species are represented. Whiskers represent 1 standard error. Early-successional forest species (Schlossberg and King 2007) are represented with a superscript a.

and diversity of birds differed among study areas ($P \leq 0.003$). During 2012–2013 (when we sampled all 3 study areas), the number and diversity of birds were 1.7–2.7 and 1.5–2.4 times greater, respectively, at singing grounds than random forest sites ($P \leq 0.036$; Fig. 2) despite differences among study areas ($P \leq 0.035$).

The cumulative number of expected species was always higher at singing grounds (Fig. 3). Following extrapolation, 14 more species were expected at singing grounds ($n = 48$; 95% CI = 41–56) than random forest sites ($n = 34$; 95% CI = 28–41).

DISCUSSION

Bird Assemblages at Singing Grounds and Random Sites

The composition of bird assemblages differed between woodcock singing grounds and random forest sites.

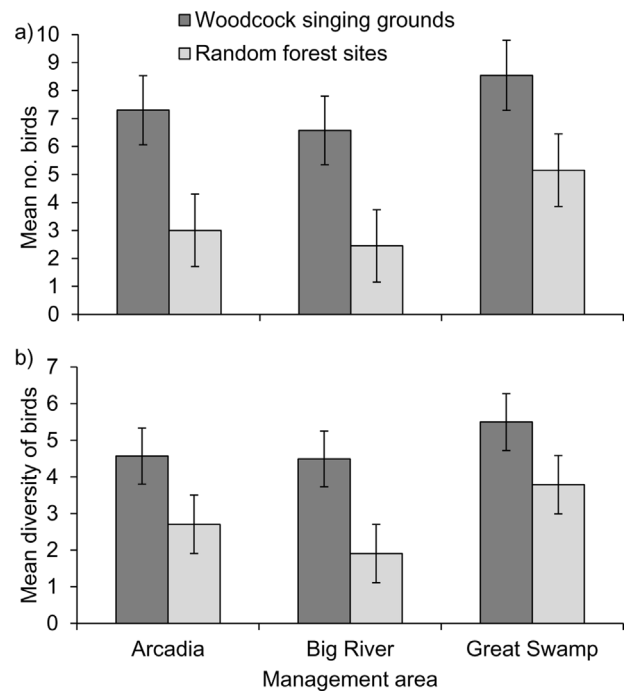


Figure 2. Mean number of birds (a) and diversity of birds (b) per 50-m plot at woodcock singing grounds and nearby random forest sites based on 10-minute point count surveys conducted from 27 May to 2 July 2011–2013 at Arcadia and Great Swamp Wildlife Management Areas, and 2012–2013 at Big River Wildlife Management Area, in Kent and Washington Counties, Rhode Island, USA. Whiskers represent 95% confidence intervals.

Schlossberg and King (2007) classified 41 New England species as core early-successional forest birds based on expert opinions and habitat preferences. The majority of the species occurring more frequently at singing grounds were core early-successional forest birds, whereas species occurring more frequently at random forest sites were forest generalists or older-forest birds (for full species lists see Masse 2014). Moreover, 5 of 6 most commonly occurring

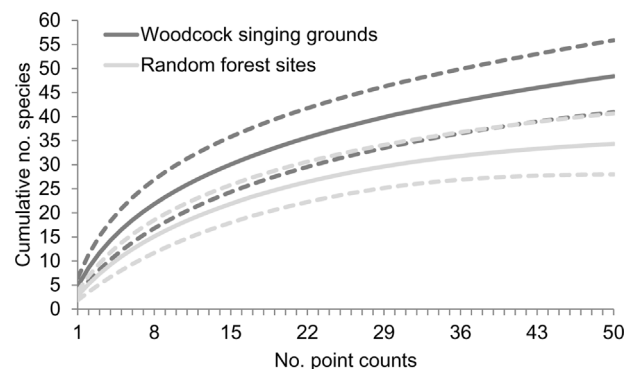


Figure 3. Sample-based rarefaction curves showing the cumulative number of species expected (solid lines) at woodcock singing grounds ($n = 43$) and random forest sites ($n = 30$) in Kent and Washington Counties, Rhode Island, USA, based on 10-minute point count surveys conducted from 27 May to 2 July 2011–2013 at Arcadia and Great Swamp Wildlife Management Areas, and 2012–2013 at Big River Wildlife Management Area. Rarefaction curves were extrapolated to 50 point count surveys each. Dashed lines represent 95% confidence intervals.

core early-successional forest birds were less abundant or completely absent at random forest sites (Fig. 1). It is well documented that abundance or density measures may not correlate well with habitat quality (Van Horne 1983), but inferring the quality of singing grounds as habitat for non-target birds was beyond the scope of our study. Our results suggest that small (e.g., 2–5-ha) early-successional forest openings managed for singing grounds provide at least some benefit to a unique assemblage and greater diversity of non-target birds in the form of usable habitat. Productivity and survival of early-successional forest birds is typically not reduced in smaller patch sizes (Rodewald and Vitz 2005, Lehnert and Rodewald 2009), but direct assessments of the quality of different sized forest openings managed for singing grounds as habitat for certain non-target birds (e.g., prairie warbler or gray catbird) are logical next steps to help strengthen the support for woodcock to serve as an effective umbrella species.

The total number and diversity of birds differed among study areas but were always at least 1.5 times greater at singing grounds than random forest sites (Fig. 2). In New York, USA, bird abundance and diversity were >2 times greater in 6-year-old forest clearcuts than more mature even-aged stands (Keller et al. 2003) and bird diversity was greater in forests subjected to clearcutting than forest reserves in New Hampshire, USA (Welsh and Healy 1993). Forest clearcuts 3–12 years old also contained greater bird diversity than pole-sized or mature forests in Virginia, USA (Conner and Adkisson 1975). Managing early-successional forest openings to provide singing grounds necessarily results in the creation of habitat edges and these edges often enhance wildlife diversity because of increased vegetative complexity or close proximity of disparate vegetation types (Leopold 1933, Johnston 1947, Yahner 2000). Some edge effects (e.g., increased predation or brood parasitism) may be detrimental to forest birds in agricultural landscapes (Donovan et al. 1997, Hoover et al. 2006), but in forest-dominated regions of the Northeast, negative edge effects may be less impactful (Rudnicki and Hunter 1993, Yahner 2000). Forest clearcuts and wildlife openings provide necessary habitat for early-successional forest species (Chandler et al. 2009, King et al. 2009) and forest generalist or edge-species also occur in managed early-successional forest openings used by breeding woodcock (Masse 2014), which further increases the abundance and diversity of birds found at singing grounds.

Our finding that bird diversity was greater at singing grounds than at random forest sites likely extends to spatial scales beyond the individual study areas that we investigated. Indeed, species accumulation curves from composite point count surveys suggested that greater bird diversity was expected at singing grounds across southern Rhode Island (Fig. 3). A cautious interpretation of this result may be warranted given slight overlap in 95% confidence intervals, but minor overlap in 95% confidence intervals from independent samples likely reflects statistically significant results (i.e., $P < 0.05$; Cumming 2009). Nevertheless, this result is encouraging because the composition of bird assemblages often differs between forest types (Sabo 1980,

DeGraaf and Chadwick 1987, Díaz 2006) and point count surveys at random forest sites occurred in a greater diversity of forest types than those at singing grounds (Masse 2014). Despite differences in landscape composition among study areas, bird diversity at singing grounds was greater than the collective diversity in other forest types, which highlights the importance of early-successional forest openings for regional bird conservation.

Can Woodcock Serve as an Effective Umbrella Species?

Widespread, active forest management is required to conserve woodcock populations (Kelley et al. 2008), which have declined as a result of habitat loss and degradation (Dessecker and McAuley 2001, McAuley et al. 2005). Clearcutting patches of older, secondary forest is the most efficient method for increasing the extent of early-successional forest for woodcock (McAuley et al. 1996, Dessecker and McAuley 2001, Williamson 2010) and it is estimated that >22,000 km² of early-successional forest needs to be managed in the Northeast to restore woodcock populations to levels observed during the 1970s (Kelley et al. 2008). In addition, populations of many other early-successional forest birds have also declined as a result of habitat loss and degradation, and are likely to benefit from such extensive forest management (Brawn et al. 2001, DeGraaf and Yamasaki 2003). Indeed, of the 22 core early-successional forest species we observed, ≥55% occurred at singing grounds, whereas ≤32% occurred at random forest sites (Masse 2014). However, populations of more mature forest species may decline in response to disturbances such as timber harvest (Gram et al. 2003, Wallendorf et al. 2007). Importantly, detailed best management practices provide specific prescriptions that public and private land managers interested in woodcock conservation can follow to improve woodcock habitat (Williamson 2010), which further enhances the efficacy of the woodcock to serve as an umbrella species.

Early-successional forest birds are typically less common or absent in older, secondary forests, whereas mature forest birds generally avoid early-successional forests during the breeding season (Welsh and Healy 1993, Keller et al. 2003, Wallendorf et al. 2007). However, recent research suggests that patches of early-successional forest provide important habitat for some mature forest species during the post-fledging period (Chandler et al. 2012, Porneluzi et al. 2014). For example, in Minnesota, USA, 28 of 62 species captured in 2–10-year-old regenerating clearcuts were mature-forest species (Streby et al. 2011) and survival of fledgling ovenbirds was higher in 7–20-year-old clearcuts than mature forest (Streby and Andersen 2013). Thus, maintaining some early-successional forest should be viewed as a means to promote regional bird diversity and conservation.

MANAGEMENT IMPLICATIONS

Public perceptions of early-successional forests are often negative (Gobster 2001) so land managers should target species whose conservation simultaneously benefits diverse non-target wildlife to balance public tolerance of unpopular

vegetation types and the needs of declining populations. In the Northeast, woodcock habitat can effectively be improved by creating a mosaic of ≥ 2 -ha clearcuts on about 25% of 200–400-ha landscapes (Williamson 2010). Clearcuts > 1 –4 ha are likely to be used by most core early-successional forest birds (Schlossberg and King 2007); therefore, woodcock habitat management can reasonably be expected to benefit many of these non-target species. We provided evidence that a dissimilar and more diverse assemblage of non-target birds occurs in managed woodcock habitat than nearby random forest sites. Thus, woodcock can serve as an effective umbrella species, and we suggest adopting even-aged forest management practices where appropriate to concurrently improve woodcock habitat and conserve early-successional forest birds. Our findings that abundance and diversity of bird species were greater at woodcock singing grounds (i.e., managed early-successional forest openings) than random forest sites highlight the important role that strategic forest clearcutting can play in regional bird conservation programs in the Northeast.

ACKNOWLEDGMENTS

We thank T. Heywood, S. Camillieri, A. Hunt, A. Padula, W. Shean, L. Barnard, D. Duffin, and D. McAuley for their help in the field and A. Smith for advice regarding mixed modeling. We also thank B. Buffum, R. McKinney, D. Andersen, and W. Thogmartin for helpful comments on earlier versions of this manuscript. Funding for this project was provided by the Rhode Island Department of Environmental Management via USFWS Federal Aid to Wildlife Investigations Project W-23R, the United States Department of Agriculture McIntire-Stennis (MS-975) and Hatch (H-333) grants, the Rhode Island Agricultural Experiment Station, and the Department of Natural Resources Science at University of Rhode Island. This is contribution number 5429 of the Rhode Island Agricultural Experiment Station.

LITERATURE CITED

- Allredge, M. W., T. R. Simons, and K. H. Pollock. 2007a. A field evaluation of distance measurement error in auditory avian point count surveys. *Journal of Wildlife Management* 71:2759–2766.
- Allredge, M. W., T. R. Simons, and K. H. Pollock. 2007b. Factors affecting aural detections of songbirds. *Ecological Applications* 17:948–955.
- Andelman, S. J., and W. F. Fagan. 2000. Umbrellas and flagships: efficient conservation surrogates or expensive mistakes? *Proceedings of the National Academy of Sciences USA* 97:5954–5959.
- Brawn, J. D., S. K. Robinson, and F. R. Thompson III. 2001. The role of disturbance in the ecology and conservation of birds. *Annual Review of Ecology and Systematics* 32:251–276.
- Buffum, B., S. R. McWilliams, and P. V. August. 2011. A spatial analysis of forest management and its contribution to maintaining the extent of shrubland habitat in southern New England, United States. *Forest Ecology and Management* 262:1775–1785.
- Caro, T. M., and G. O'Doherty. 1999. On the use of surrogate species in conservation biology. *Conservation Biology* 13:805–814.
- Chandler, C. C., D. I. King, and R. B. Chandler. 2012. Do mature forest birds prefer early-successional habitat during the post-fledging period? *Forest Ecology and Management* 264:1–9.
- Chandler, R. B., D. I. King, and C. C. Chandler. 2009. Effects of management regime on the abundance and nest survival of shrubland birds in wildlife openings in northern New England, USA. *Forest Ecology and Management* 258:1669–1676.
- Colwell, R. K., A. Chao, N. J. Gotelli, S.-Y. Lin, C. X. Mao, R. L. Chazdon, and J. T. Longino. 2012. Models and estimators linking individual-based and sample-based rarefaction, extrapolation and comparison of assemblages. *Journal of Plant Ecology* 5:3–21.
- Colwell, R. K., C. X. Mao, and J. Chang. 2004. Interpolating, extrapolating, and comparing incidence-based species accumulation curves. *Ecology* 85:2717–2727.
- Conner, R. N., and C. S. Adkisson. 1975. Effects of clearcutting on the diversity of breeding birds. *Journal of Forestry* 73:781–785.
- Cooper, T. R., and R. D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, Maryland, USA.
- Cumming, G. 2009. Inference by eye: reading the overlap of independent confidence intervals. *Statistics in Medicine* 28:205–220.
- DeGraaf, R. M., and N. L. Chadwick. 1987. Forest type, timber size class, and New England breeding birds. *Journal of Wildlife Management* 51:212–217.
- DeGraaf, R. M., and M. Yamasaki. 2003. Options for managing early-successional forest and shrubland bird habitats in the northeastern United States. *Forest Ecology and Management* 185:179–191.
- DeJong, M. J., and J. T. Emlen. 1985. The shape of the auditory detection function and its implication for songbird censusing. *Journal of Field Ornithology* 56:213–223.
- Dessecker, D. R., and D. G. McAuley. 2001. Importance of early successional habitat to ruffed grouse and American woodcock. *Wildlife Society Bulletin* 29:456–465.
- Dettmers, R. 2003. Status and conservation of shrubland birds in the northeastern US. *Forest Ecology and Management* 185:81–93.
- Díaz, L. 2006. Influences of forest type and forest structure on bird communities in oak and pine woodlands in Spain. *Forest Ecology and Management* 223:54–65.
- Donovan, T. M., P. W. Jones, E. M. Annand, and F. R. Thompson III. 1997. Variation in local-scale edge effects: mechanism and landscape context. *Ecology* 78:2064–2075.
- Enser, R. W., and J. A. Lundgren. 2006. Natural communities of Rhode Island. Rhode Island Natural History Survey, Kingston, USA. http://rinhs.org/wpcontent/uploads/2012/05/ri_nat_comms_2006.pdf. Accessed 19 Oct 2013.
- Fleishman, E., D. D. Murphy, and P. F. Brussard. 2000. A new method for selection of umbrella species for conservation planning. *Ecological Applications* 10:569–579.
- Gobster, P. H. 2001. Human dimensions of early successional landscapes in the eastern United States. *Wildlife Society Bulletin* 29:474–482.
- Gram, W. K., P. A. Porneluzi, R. L. Clawson, J. Faaborg, and S. C. Richter. 2003. Effects of experimental forest management on density and nesting success of bird species in Missouri Ozark forests. *Conservation Biology* 17:1324–1337.
- Hoover, J. P., T. H. Tear, and M. E. Baltz. 2006. Edge effects reduce the nesting success of Acadian flycatchers in a moderately fragmented forest. *Journal of Field Ornithology* 77:425–436.
- Hurme, E., M. Mönkkönen, A.-L. Sippola, H. Ylinen, and M. Penttinen. 2008. Role of the Siberian flying squirrel as an umbrella species for biodiversity in northern boreal forests. *Ecological Indicators* 8:246–255.
- Johnston, V. R. 1947. Breeding birds of the forest edge in Illinois. *Condor* 49:45–53.
- Jost, L. 2006. Entropy and diversity. *Oikos* 113:363–375.
- Keller, J. K., M. E. Richmond, and C. R. Smith. 2003. An explanation of patterns of breeding bird species richness and density following clearcutting in northeastern USA forests. *Forest Ecology and Management* 174:541–564.
- Kelley, J., S. Williamson, and T. R. Cooper, editors. 2008. American woodcock conservation plan: a summary of and recommendations for woodcock conservation in North America. Wildlife Management Institute. http://timberdoodle.org/sites/default/files/woodcockPlan_0.pdf. Accessed 19 Oct 2013.
- King, D. I., R. B. Chandler, S. Schlossberg, and C. C. Chandler. 2009. Habitat use and nest success of scrub-shrub birds in wildlife and silvicultural openings in western Massachusetts, USA. *Forest Ecology and Management* 257:421–426.
- Kramer, C. Y. 1956. Extension of multiple range tests to group means with unequal numbers of replications. *Biometrics* 12:307–310.

- Lambeck, R. J. 1997. Focal species: a multi-species umbrella for nature conservation. *Conservation Biology* 11:849–856.
- Lehnen, S. E., and A. D. Rodewald. 2009. Investigating area-sensitivity in shrubland birds: responses to patch size in a forested landscape. *Forest Ecology and Management* 257:2308–2316.
- Leopold, A. 1933. *Game management*. 1986, Reprint. Charles Scribner's Sons, New York, New York, USA.
- Magurran, A. E. 2004. *Measuring biological diversity*. Blackwell, Malden, Massachusetts, USA.
- Masse, R. J. 2014. American woodcock ecology and bird conservation in relation to forest management. Dissertation, University of Rhode Island, Kingston, USA.
- Masse, R. J., B. C. Tefft, and S. R. McWilliams. 2014. Multiscale habitat selection by a forest-dwelling shorebird, the American woodcock: implications for forest management in southern New England, USA. *Forest Ecology and Management* 325:37–48.
- McAuley, D. G., J. R. Longcore, D. A. Clugston, R. B. Allen, A. Weik, S. Williamson, J. Dunn, B. Palmer, K. Evans, W. Staats, G. F. Sepik, and W. Halteman. 2005. Effects of hunting on survival of American woodcock in the Northeast. *Journal of Wildlife Management* 69:1565–1577.
- McAuley, D. G., J. R. Longcore, G. F. Sepik, and G. W. Pendleton. 1996. Habitat characteristics of American woodcock nest sites on a managed area in Maine. *Journal of Wildlife Management* 60:138–148.
- Noss, R. F. 1990. Indicators for monitoring biodiversity: a hierarchical approach. *Conservation Biology* 4:355–364.
- Pakkala, T., J. Pellikka, and H. Lindén. 2003. Capercaillie (*Tetrao urogallus*) —a good candidate for an umbrella species in taiga forests. *Wildlife Biology* 9:309–316.
- Pierce, B. L., R. R. Lopez, and N. J. Silvy. 2012. Estimating animal abundance. Pages 284–310 in N. J. Silvy, editor. *The wildlife techniques manual*. Seventh edition. Volume 1. John Hopkins University, Baltimore, Maryland, USA.
- Porneluzi, P. A., R. Brito-Aguilar, R. L. Clawson, and J. Faaborg. 2014. Long-term dynamics of bird use of clearcuts in post-fledging period. *Wilson Journal of Ornithology* 126:623–634.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. *Handbook of field methods for monitoring landbirds*. U.S. Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-144-www, Albany, California, USA.
- Rhode Island Geographic Information System. 2012. Forest habitat. Rhode Island Geographic Information System Data Distribution System, Environmental Data Center, University of Rhode Island, Kingston, USA. <http://www.edc.uri.edu/rigis>. Accessed 21 Oct 2013.
- Rodewald, A. D., and A. C. Vitz. 2005. Edge- and area-sensitivity of shrubland birds. *Journal of Wildlife Management* 69:681–688.
- Rowland, M. M., M. J. Wisdom, L. H. Suring, and C. W. Meinke. 2006. Greater sage-grouse as an umbrella species for sagebrush-associated vertebrates. *Biological Conservation* 129:323–335.
- Rudnicki, T. C., and M. L. Hunter, Jr. 1993. Avian nest predation in clearcuts, forests, and edges in a forest-dominated landscape. *Journal of Wildlife Management* 57:358–364.
- Sabo, S. R. 1980. Niche and habitat relations in subalpine bird communities of the White Mountains of New Hampshire. *Ecological Monographs* 50:241–259.
- Sattler, T., G. B. Pezzatti, M. P. Nobis, M. K. Obrist, T. Roth, and M. Moretti. 2014. Selection of multiple umbrella species for functional and taxonomic diversity to represent urban biodiversity. *Conservation Biology* 28:414–426.
- Schlossberg, S., and D. I. King. 2007. *Ecology and management of scrub-shrub birds in New England: a comprehensive review*. Natural Resources Conservation Service, Resource Inventory and Assessment Division, Beltsville, Maryland, USA.
- Shapiro, S. S., and M. B. Wilk. 1965. An analysis of variance test for normality (complete samples). *Biometrika* 52:591–611.
- Sheldon, W. G. 1967. *The book of the American woodcock*. University of Massachusetts, Amherst, USA.
- Simberloff, D. 1998. Flagships, umbrellas, and keystones: is single-species management passé in the landscape era? *Biological Conservation* 83:247–257.
- Streby, H. M., and D. E. Andersen. 2013. Movements, cover-type selection, and survival of fledgling ovenbirds in managed deciduous and mixed deciduous-coniferous forests. *Forest Ecology and Management* 287:9–16.
- Streby, H. M., S. M. Peterson, T. L. McAllister, and D. E. Andersen. 2011. Use of early-successional managed northern forest by mature-forest species during the post-fledging period. *Condor* 113:817–824.
- Van Horne, B. 1983. Density as a misleading indicator of habitat quality. *Journal of Wildlife Management* 47:893–901.
- Wallendorf, M. J., P. A. Porneluzi, W. K. Gram, R. L. Clawson, and J. Faaborg. 2007. Bird response to clear cutting in Missouri Ozark forests. *Journal of Wildlife Management* 71:1899–1905.
- Welsh, C. J. E., and W. M. Healy. 1993. Effect of even-aged timber management on bird species diversity and composition in northern hardwoods of New Hampshire. *Wildlife Society Bulletin* 21:143–154.
- Wildlife Management Institute. 2014. WMI homepage. <http://www.wildlifemanagementinstitute.org>. Accessed 29 Dec 2014.
- Williamson, S. J. 2010. American woodcock: habitat best management practices for the Northeast. U.S. Department of Agriculture, Natural Resources Conservation Service Wildlife Insight 89, Washington, D.C., USA.
- Yahner, R. H. 2000. *Eastern deciduous forest: ecology and wildlife conservation*. Second edition. University of Minnesota, Minneapolis, USA.

Associate Editor: Wayne Thogmartin.