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Comparing bird communities within shrubby transmission line rights-of-way managed by mowing or by selective herbicide application in Maine and New Hampshire

Kathleen P. Wadiak
University of New Hampshire, Durham

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Honors Thesis Advisor: Matthew Tarr

Abstract: In the northeastern U.S., thousands of miles of shrub-dominated transmission line rights-of-way (ROW) extend across the landscape and provide some of the largest and most stable shrubland habitats in the region. These ROW are used as nesting and post-fledging habitat by the region's entire community of shrubland-dependent songbirds, but evidence for how ROW are used by songbirds that require other habitats for nesting is lacking. Mist-netting surveys conducted in regenerating clearcuts indicate that adult and fledgling mature-forest songbirds comprise a large proportion of the bird community in clearcuts during the post-fledging portion of the breeding season, a time when juvenile birds and molting adults require dense cover to avoid predators and abundant food resources to prepare for migration. In 2017, we began the first comprehensive mist-netting survey ever conducted in shrubby ROW in southern Maine and New Hampshire to inventory the entire community of songbirds using ROW during the nesting and post-fledging periods. In this preliminary year of our study, we investigated whether differences in the height, density, and species composition of plants between three ROW maintained by mowing and three ROW maintained with selective herbicide treatment resulted in differences in the community of shrubland-dependent or other-habitat-dependent songbirds. We conducted six mist net surveys in each ROW from late May-late August and captured 1,153 individual birds of 44 unique species. There was no difference in the richness or diversity of "Shrubland Species," "Other Species," or the entire songbird community between the different ROW types.

Introduction

Shrublands are habitats composed mainly of low-growing, woody vegetation and little or no tree canopy cover (e.g., regenerating clearcuts, shrubby transmission line rights-of-way). In the northeastern United States, shrublands are required breeding habitat for forty-one species of shrubland-dependent bird species ("shrubland birds") that rely on the unique combination of dense shrub cover and abundant food resources (e.g., insects and fruit) typical of shrublands (Schlossberg and King 2007). These shrubland birds spend most or all of spring to autumn in shrublands breeding, raising nestlings, molting, and preparing for migration (Schlossberg and King 2007). While shrublands are required breeding habitats for shrubland birds, other bird species require mature forest habitat for nesting ("mature-forest birds"). For example, several mature-forest birds, including hairy woodpeckers (*Leuconotopicus villosus*), tufted titmice (*Baeolophus bicolor*), and white-breasted nuthatches (*Sitta carolinensis*) require mature trees with cavities to build their nests; ovenbirds (*Seiurus aurocapilla)* are mature-forest birds that nest on the ground and experience their greatest nesting success in forest interiors; and golden-crowned kinglets (*Regulus satrapa*) and blackburnian warblers (*Dendroica fusa*) are mature-forest birds that nest high in mature tree canopies (DeGraaf and Yamasaki 2001). For mature-forest birds, conversion of mature forest habitat into shrublands (e.g., by clearcutting) can result in a loss of required nesting habitat, and many mature-forest species have been assumed to avoid shrublands throughout the breeding season.

Despite this, a growing body of literature indicates that mature-forest birds may benefit from shrubland habitat during the post-fledging portion of the breeding season (the time after young birds leave or "fledge" the nest and before they migrate south in autumn; Anders et al. 1998, Pagen et al. 2000, Marshall et al. 2003, King et al. 2006, Vitz and Rodewald 2006). For

example, juvenile wood thrushes (*Hylocichla mustelina*) and ovenbirds have been found using regenerating clearcuts where dense shrubs may provide especially important cover from predators (Anders et al 1998, King et al. 2006). Regenerating clearcuts may also provide an abundance of insects and fruits that may be important for improving fledgling survival and for helping mature-forest birds prepare for autumn migration (Anders et al. 1998, Marshall et al. 2003). Bird inventories conducted during the post-fledging period indicate that mature-forest bird species may account for a large proportion of the bird community in regenerating clearcuts (Pagen et al. 2000, Vitz and Rodewald 2006). Although some species of mature-forest birds, including red-eyed vireos (*Vireo olivaceus*), black-capped chickadees (*Poecile atricapillus*), scarlet tanagers (*Piranga olivacea*), and least flycatchers (*Empidonax minimus*) have been documented using transmission line rights-of-way (ROW) during the nesting season (Anderson 1979, Chasko and Gates 1982, Bramble et al. 1992), no studies have yet reported whether shrubby ROW are used in a similar manner as clearcuts by mature-forest birds.

In the northeastern U.S., most transmission line ROW are maintained in a constant shrubland condition by the utility companies responsible for ensuring that tall vegetation does not contact the transmission lines and interrupt the flow of electricity. These shrubby ROW provide large areas of shrubland habitat (Askins 1994, King and Byers 2002, Confer and Pascoe 2003) known to serve as important nesting and foraging sites for shrubland birds, including common yellowthroats (*Geothlypis trichas*), eastern towhees (*Pipilo erythrophthalmus*), gray catbirds (*Dumetella carolinensis*), field sparrows (*Spizella pusilla*), indigo buntings (*Passerina cyanea*), and chestnut-sided warblers (*Setophaga pensylvanica*) (Kroodsma 1982, Bramble and Byrnes 1983, Bramble et al. 1984, King et al. 2009). Tall trees are removed from within each ROW typically either by mowing and/or by selective application of herbicides. In southeastern

New Hampshire, ROW are maintained in a shrubby condition by mowing with a brontosaurus-style forestry mower every three to four years. This generally creates a ROW dominated by tall (< 4m) hardwood stump sprouts interspersed with shorter shrubs and herbaceous plants. In neighboring southern Maine, many ROW are maintained using herbicides sprayed selectively on invasive shrubs, tall trees, and hardwood sprouts, and this typically creates a ROW dominated by a relatively uniform cover of short-growing shrubs.

Importantly, the specific method used to maintain a ROW influences the species and structure of plants that grow within it, and this may result in differences in what bird species use ROW maintained by the different methods. For example, mowed ROW in Pennsylvania consisted of very short (< 6" tall) trees and shrubs, and a wildflower-grass dominated habitat that resulted in a reduction in bird species richness after mowing (Bramble et al. 1992). Yahner et al. (2002), also working in Pennsylvania, found that a mowed ROW supported shrubland birds including cedar waxwings (*Bombycilla cedrorum*), chestnut-sided warblers, common yellowthroats, and field sparrows. Comparatively, ROW treated with herbicides were composed of a low density of trees and a shrub-wildflower-grass community which supported a large and diverse bird community (Bramble et al. 1992). These types of ROW contained the same shrubland birds as the mowed segments, but also mature-forest birds including northern flickers (*Colaptes auratus)*, tufted titmice, and wood thrushes, leading Yahner et al. (2002) to conclude that ROW treated with herbicide supported both a greater abundance of birds and number of bird species than mowed ROW.

While these previous studies indicate the important role that mowing or herbicide treatment can have on determining both the plants and birds that use ROW, all of these studies have been conducted in the Mid-Atlantic States on ROW that are significantly less shrubby than

ROW in the northeastern U.S. Further, previous studies have relied almost entirely on standard auditory and visual-based bird surveys conducted during the breeding season to determine the composition of birds using ROW (Pearson 1993, Yahner et al. 2002, Confer and Pascoe 2003, King et al. 2009, but see Meehan and Haas 1997). These survey methods are limited in their ability to detect the entire community of birds using ROW because they rely on the observer's ability to detect and accurately identify birds in habitat that is often composed of very dense vegetation; these methods often fail to detect birds that are not vocalizing (e.g., juvenile birds, non-breeding individuals, female birds, post-breeding mature-forest birds) and they are not conducted during the post-fledging period when many mature-forest birds are likely to move into ROW (Pagan et al. 2000).

In order to determine how the method of managing ROW influences the songbird community, this study had the following three objectives: 1) Quantify differences in the species richness and diversity of "Shrubland Species" of birds between ROW managed by mowing and ROW managed by selective herbicide application. 2) Quantify differences in the species richness and diversity of "Other Species" of birds (including mature-forest species, edge species, and other species that are not shrubland obligates) between ROW managed by mowing and ROW managed by selective herbicide application. 3) Quantify differences the species richness and diversity of the entire bird community between ROW managed by mowing and ROW managed by selective herbicide application. The results of this study will be used immediately to develop standards for conservation practices associated with the USDA Natural Resources Conservation Service's Environmental Quality Incentives Program, aimed at improving shrubland habitat for birds and pollinators in Maine and New Hampshire. I conducted this study as part of a larger project investigating songbird use of clearcuts and ROW being conducted by my faculty advisor

(Matt Tarr, UNHCE/NREN), Dr. Adrienne Kovach (NREN), and M.S. student Erica Holm (UNH NREN).

Methods

This study was conducted on three ROW in New Hampshire (Rockingham and Strafford Co.) that were maintained by mowing and three ROW in Maine (York Co.) that were maintained by herbicide application (Fig 1); each type of ROW was managed with its respective method (mowing or herbicide application) for ≥ 15 years prior to the beginning of the study. We used constant-effort mist netting to quantify bird density and species composition at each study site once every two weeks, for a total of six sample days between 29 May and 18 August.

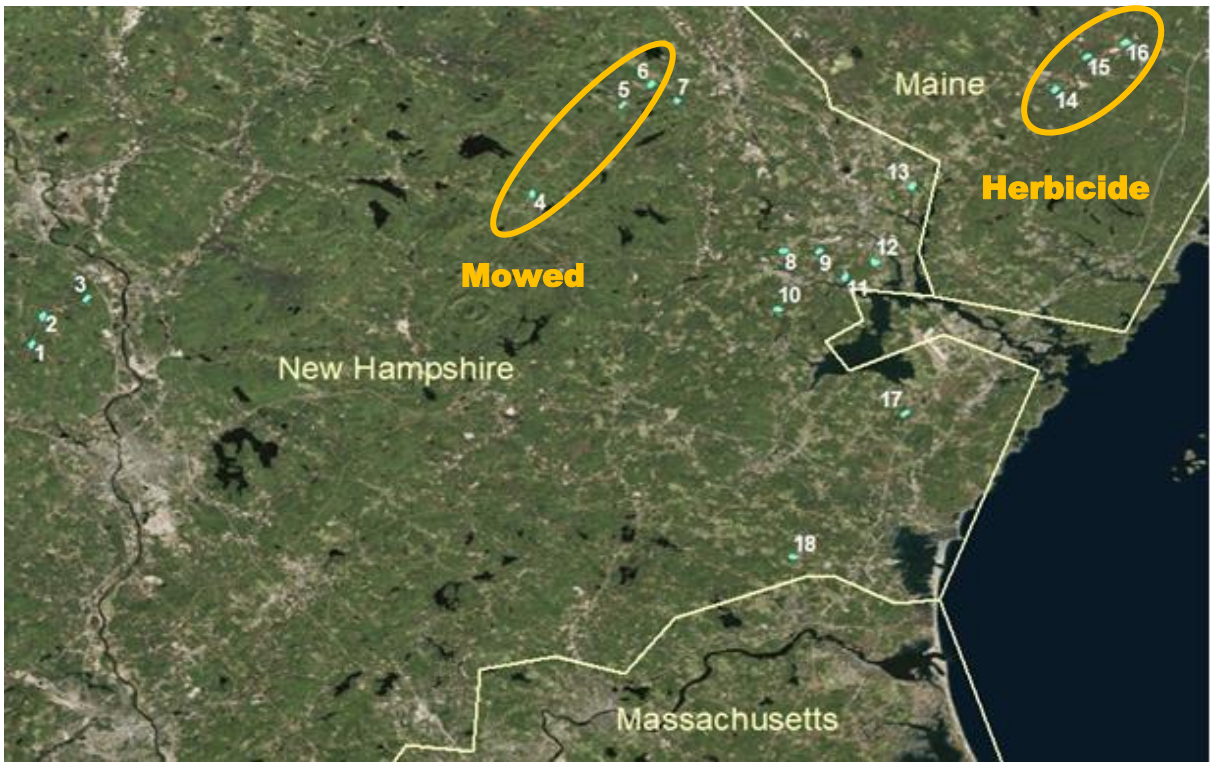

Figure 1. Map of study sites. Numbers 4, 5, and 6 are mowed sites. Numbers 14, 15, and 16 are herbicide-treated sites. Other numbers are sites selected for the larger UNH Shrubland Bird Project in 2017.

We used constant-effort mist netting instead of visual and auditory surveys to yield a more complete inventory of bird species using ROW. Constant-effort mist netting involves setting up an array of mist nets that catch birds passively during the sampling period. The nets we used were designed to catch passerines, cuckoos, doves, and most woodpeckers. A total of 8 mist nets (30 mm mesh, 12 m long, 2.5 m high) were arranged systematically along a 350m length of each ROW, positioned every 50m, alternating between two net categories (Fig 2): EDGE (net center 10m from nearest ROW edge, n=4 nets) and CENTER (net center 38m from nearest ROW edge, n=4 nets). Nets were arranged perpendicular to the ROW edge in order to minimize the chance of capturing birds that were only flying across the ROW between adjacent habitats. Nets were opened at sunrise and allowed to catch songbirds passively for a total of 4 hours each sample day. Each net that was opened for 1 hour was considered "1 net-hour" of sampling.

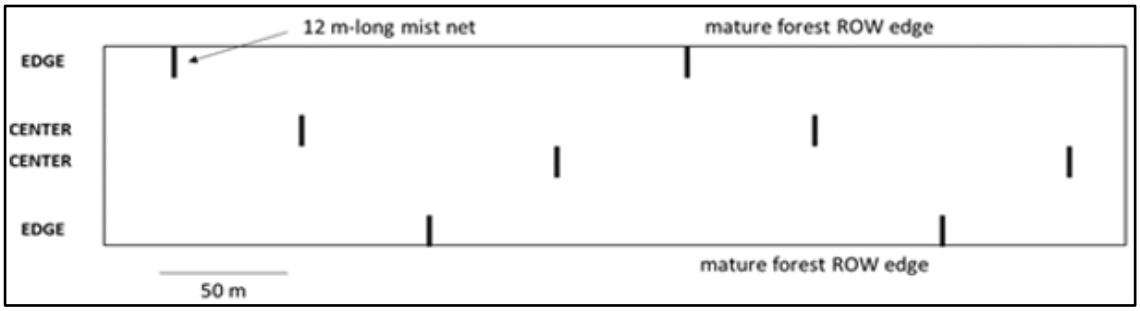

Figure 2. Mist net set-up in ROW

Birds were removed from nets every 10-15 minutes, identified as either shrubland-specialists ("Shrubland Species") or non-shrubland specialists ("Other Species," Table 1) and banded with a numbered United States Geological Survey band (except for ruby-throated hummingbirds that were simply released without banding). Banding birds was required to

identify individuals that have been caught previously and to calculate an accurate estimate of the total number of birds captured within each ROW type.

Table 1. Habitat category of species captured on study sites

Shrubland Species		Other Species	
Alder flycatcher	House wren	American robin	Ovenbird
American goldfinch	Indigo bunting	Bank swallow	Purple finch
Black-and-white warbler	Lincoln's sparrow	Baltimore oriole	Red-eyed vireo
Black-billed cuckoo	Prairie warbler	Eastern phoebe	Scarlett tanager
Blue-winged warbler	Ruby-throated hummingbird	Rose-breasted grosbeak	Tufted titmouse
Canada warbler	Song sparrow	House sparrow	Veery
Cedar waxwing	White-throated sparrow	Hooded warbler	Wood thrush
Common yellowthroat	Magnolia warbler	American redstart	Black-throated green warbler
Chestnut-sided warbler	Northern cardinal	Black-capped chickadee	Hairy woodpecker
Eastern towhee	Wilson's warbler	Blue jay	Swainson's thrush
Field sparrow	Yellow warbler	Eastern wood pewee	
Gray catbird			

For each ROW type, I calculated the species richness (total # of species) and Shannon's Diversity Index for "Shrubland Species," "Other Species," and the entire bird community. For

each bird habitat category, I calculated Shannon's Diversity Index (*H*) as: H = SUM [(p_i) * ln(p_i), where p_i = total number of individuals of species "i" captured/total # of species captured. For all objectives, I conducted two-tailed t-tests to determine if there were differences in either species richness or *H* between each ROW type. This project was approved by the UNH Institutional Animal Care and Use Committee (Protocol # 161201).

Results

We captured a total of 1,153 individual birds representing 44 species over approximately 1141 total net hours of sampling across all sites. We captured a total of 593 birds representing 35 species from the three sites treated with selective-herbicide. Of these, nine species were unique to the herbicide sites, including: the black-billed cuckoo (*Coccyzus erythropthalmus*), Lincoln's sparrow (*Melospiza lincolnii*), blue-winged warbler (*Vermivora cyanoptera*), white-throated sparrow (*Zonotrichia albicollis*), blue jay (*Cyanocitta cristata*), wood thrush, purple finch (*Haemorhous purpureus*), eastern wood pewee *(Contopus virens*), and bank swallow (*Riparia riparia*). The three most abundant species were the common yellowthroat (n=110), song sparrow (n=100), and gray catbird (n=82).

We captured a total of 560 birds representing 35 species from the three mowed sites. There were nine species that were only captured on mowed sites, including the northern cardinal (*Cardinalis cardinalis*), yellow warbler (*Setophaga petechia*), Wilson's warbler (*Cardellina pusilla*), magnolia warbler (*Setophaga magnolia*), hairy woodpecker, Swainson's thrush (*Catharus ustulatus*), black-throated green warbler (*Setophaga virens*), hooded warbler (*Setophaga citrina*), and house sparrow (*Passer domesticus*). Common yellowthroats (n=91), gray catbirds (n=80), and prairie warblers (*Setophaga discolor*, n=66) were the three most abundant species on the mowed ROW.

We found no difference in the average species richness (t = 0.15, df = 4, *P* = 0.89) or Shannon's Diversity Index (t = 0.98, df = 4, *P* = 0.38) of the entire songbird community between mowed ROW (25.3 species, *H = 2.69*) and ROW maintained by herbicide application (24.7 species, *H* = 2.54, Fig 3). Similarly, there was no difference in the species richness (t = 1.49, df = 4, *P* = 0.21) or diversity (t = 3.14, df = 3, *P* = 0.05) of "Shrubland Species" in ROW maintained by mowing (17 species, *H* = 2.41) or by selective herbicide application (14.7 species, *H* = 2.16, Fig. 4). We also did not find a difference in the richness (t = -0.49, df = 4, *P* = 0.65) or diversity (t = -0.22, df = 3, *P* = 0.84) of "Other Species" between the two site types (mowed: 8.3 species, *H*=1.81; herbicide: 10 species, *H*=1.91, Fig 2).

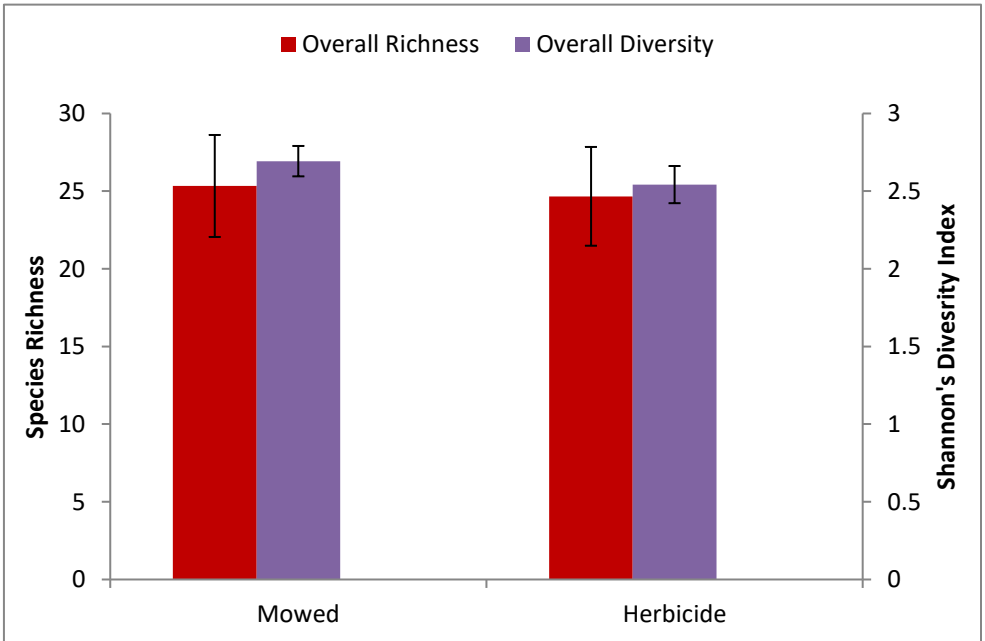

Figure 3. Species richness and Shannon's Diversity Index of the entire songbird community captured in ROW maintained by mowing or selective herbicide application

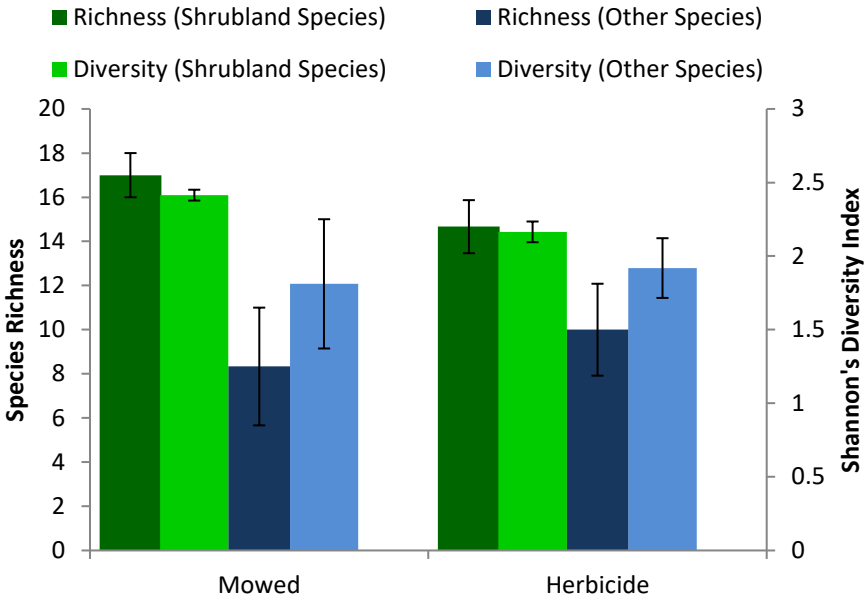

Figure 4. Species richness and Shannon's Diversity Index of shrubland species and other species on ROW maintained by mowing or selective herbicide application

Discussion

These results indicate that both mowing and selective herbicide application created ROW that were capable of supporting large, diverse songbird communities. These communities included both shrubland obligate species such as common yellowthroats, gray catbirds, prairie warblers, and alder flycatchers (*Empidonax alnorum*), and mature forest species including tufted titmice, ovenbirds, and black-capped chickadees. They also attracted species that occupy the edges of these habitats, including rose-breasted grosbeaks (*Pheucticus ludovicianus*), eastern phoebes (*Sayornis phoebe*), and Baltimore orioles (*Icterus galbula*).

Although the species richness and diversity were similar between site types, there were nine species unique to ROW of each management method. This may be due to differences in plant species and vegetation structure created by the two maintenance types. ROW maintained

by mowing were dominated by hardwood saplings, with scattered native and invasive shrubs, forbs, ferns and grasses. This created a relatively patchy distribution of plants growing at different heights. The vegetative cover on selective herbicide ROW was of a more uniform height, consisting of short-growing native shrubs, forbs, ferns, and grasses. There were few tall tree saplings, as these are usually targeted for removal in herbicide treatments. These contrasts may have created differences in feeding and nesting opportunities that attracted different songbird species. For example, we captured yellow warblers in all three mowed ROW, but never in ROW treated with herbicide. It is possible that these birds prefer the taller, more diverse vertical structure of the mowed ROW for their nesting habitat. It is also possible that a species being unique to a single site type was due more to its rarity on the landscape than to habitat differences between management methods, as several species that were only found on one site type were represented by just one individual, including the blue jay, black-throated green warbler, Eastern wood-pewee, hairy woodpecker, house sparrow, hooded warbler, purple finch, and white-throated sparrow. There also may be factors associated with the landscape beyond the ROW that influenced differences in the bird community, such as the composition of the surrounding forest, presence and types of wetlands, or human development.

These results are different from those found by Bramble et al. (1992) in Pennsylvania, who found that different management techniques, including mowing and herbicide application, had a subsequent effect on the songbird species and abundance on each site. Yahner et al. (2002), also conducting research in Pennsylvania, came to a similar conclusion, finding that the greatest abundance and diversity of birds were found on ROW treated with herbicide. Both of these studies relied on auditory and visual surveys instead of mist netting, so it is possible that they missed species that were not actively singing or travelling in the ROW. Regional and landscape-

level differences between New England and Pennsylvania may have also contributed to the difference in results. In addition, the ROW in these studies were not as shrub-dominated as the ones in which our study was conducted, which might have led to larger differences in the vegetation community between treatment types. Despite some differences in plant species and structure, both the mowed and herbicide-treated ROW were largely shrubland habitats. This likely contributed to the similarities in the songbird communities between the two management methods.

Our findings of forest-obligate songbirds and habitat specialists other than shrubland species in manmade shrubby habitats are consistent with other studies. For example, Pagan et al. (2000) found forest birds including the red-eyed vireo and ovenbird in regenerating clearcuts during the breeding and post-breeding season. Vitz and Rodewald (2005) drew similar conclusions in regenerating clearcuts during the post-breeding season, finding that forest-associated species such as ovenbirds, wood thrushes, and scarlet tanagers were common captures. Previous research also suggests that these habitats may be important to juvenile forest species including fledgling ovenbirds and wood thrushes (Anders et al 1998, King et al. 2005). All of these species were also present in our study ROW, which serves to further emphasize the importance of anthropogenic shrublands to a diverse group of songbirds with a variety of habitat needs.

Sites and methods were carefully considered to maximize our ability to collect accurate data, but there were still possible sources of error. Although mist netting is more thorough than auditory and visual surveys, we may have missed songbirds present in the ROW. For example, there is potential that certain species were better able to avoid capture than others, as we observed birds (e.g. swallows) repeatedly avoiding nets and birds escaping nets before we were

able to identify them. In addition, there may have been inconsistencies when identifying species, especially with fledgling songbirds which sometimes lack the distinguishing features of adults. In these cases, every effort was used to correctly identify an individual, including the use of field guides, online resources, and communication between crew members.

Shrublands are important habitats and their decline can cause a decrease in the many species that rely on them. Although there was no difference in richness and diversity between site types, ROW managed with different methods attracted different species, and an increased understanding of this can help inform management decisions focused on supporting these species. For example, there are several songbirds that use shrublands that are species of regional conservation concern, and understanding how management impacts the ability of a manmade shrubland to attract these birds may be critical to their future conservation. Alternatively, the fact that management method does not have a significant impact on the songbird community may imply a need to focus on other differences in these habitats that may play a larger role in influencing the habitat quality.

Further research into these systems is important in informing these decisions, and as this study is part of a larger project exploring the habitat factors that influence songbird use of manmade shrublands, it will contribute to further investigations and may help shape future studies. Subsequent research could focus on other factors that may be important in determining the species of birds in a ROW, such as surrounding habitats, timing of management, or microhabitats within the ROW. In addition, future studies could be used to help gain a better understanding of the specific activities and site preferences of songbirds in ROW and how these may differ between species. The ability of a site to meet the needs of these individual species may be contributing to subtle differences in the bird community.

ROW provide actively maintained, consistent shrublands that are important to several species. Their value to songbirds in the northeast has been understudied, but this research demonstrates that ROW managed by selective herbicide application or mechanical mowing provide sizable patches of shrubland habitat capable of supporting diverse songbird communities. Either method for keeping ROW in a shrubby condition appear appropriate for attracting songbirds associated with shrublands, mature forests, wetlands, and edges of these habitats. In addition, it may be important to have both types of ROW on the landscape, as each method supported a slightly different variety of birds. As natural shrublands continue to decline, ROW may become increasingly important in supporting declining songbird species and should be a focus of future research and management plans.

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