Forest Ecology and Management 327 (2014) 231–239

Contents lists available at ScienceDirect

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Vegetation composition along a New England transmission line corridor and its implications for other trophic levels

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ARTICLE INFO

Article history:
Received 23 January 2014
Received in revised form 18 April 2014
Accepted 18 April 2014

Keywords:
Plant diversity
Managed habitats
Rare species
Oligolectic bees
Non-native invasive species
Powerline

ABSTRACT

Transmission line corridors in forested landscapes provide important early successional habitats for a taxonomically rich array of native plant and animal life, including populations of rare species. We measured plant diversity and cover for 27 randomly selected paired powerline and woodland plots along a 140-km rights-of-way corridor that extended from northern Connecticut into southern New Hampshire. Mean plant richness was significantly higher in powerline plots ($\bar{x}$ = 49.8 species) than in woodland plots ($\bar{x}$ = 29.5 species). Powerline plots with the greatest richness were those that included a maintenance road or other areas of disturbed, open soil. Three hundred and twenty-six plant species were recorded in powerline plots, more than twice the number found in woodland plots (n = 157). Powerline plots had higher invasive plant cover than the woodland plots, but non-native invasive species cover was low (<2%) in both powerline and woodland plots. Cover of clonal species was greater in the powerline plots (mean values of 12.0% ±1.2 vs. 4.0% ±0.6). Northern powerline plots in our study, maintained exclusively by mowing, had a higher proportion of tree cover than southern plots that were maintained by mowing plus spot-application of herbicides. No differences were found in the proportional cover of all woody plants, clonal species, or invasive species among the two management types. We include a discussion of host-specialized Lepidoptera, oligolectic bees, and other wildlife that are dependent on vegetation composition and structure found along transmission line corridors in the Northeast.

1. Introduction

Early successional habitats dominated by graminoids, herbs, and shrubs support numerous species that are otherwise uncommon in heavily forested landscapes. Transmission line corridors (TLCs) provide much early successional habitat in forested landscapes and thus play an important role in biodiversity conservation (Russell et al., 2005; Komonen et al., 2013). Russell et al. (2005) report that transmission line rights-of-way (ROW) account for 2–3 million ha (5–8 million acres) of land in the continental United States. In New York State, utility companies manage about 48,560 ha (120,000 acres) of shrubland habitat, far more than the estimated 6171 ha (15,250 acres) of shrubland habitat intentionally managed by other agencies (Confer and Pascoe, 2003). Moreover, the importance of TLCs for conservation of early successional habitats and species across the eastern U.S. is expected to increase in the coming decades as farmlands give way to development and forest succession.

A taxonomically diverse array of early successional species is favored by vegetation management under transmission lines, including numerous grasses, sedges, forbs, pollinators (bees, butterflies, moths, beetles, flies), reptiles, grassland and shrubland birds, mammals, and others (Chasko and Gates, 1982; Bramble et al., 1992; Litvaitis et al., 1999; Hunter et al., 2001; King and Byers, 2002; Confer and Pascoe, 2003; King et al., 2005; Russell et al., 2005; Wagner, 2007; Schweitzer et al., 2011; Askins et al., 2012; Wojcik and Buchmann, 2012; Komonen et al., 2013). In the northeastern U.S. and elsewhere, where early successional[1]

[1] Most early successional habitats in the Northeast are post-European settlement communities that have come about through agriculture and other anthropogenic activities. It is estimated that between 4% and 5% of pre-settlement forests were early successional in nature (Lorimer and White, 2003), due to blow downs, fires, wind and ice damage, and beaver activity; additional early successional habitats included balds, sandplain, and barrens communities (Bromley, 1935; Foster and Motzkin, 2003; Askins, 2000).

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http://dx.doi.org/10.1016/j.foreco.2014.04.026
0378-1127/

habitats are decreasing (Vickery and Dunwiddie, 1997; Litvaitis et al., 1999; Askins, 2001; DeGraaf and Yamasaki, 2003), TLCs also provide critical habitat for numerous state- and globally imperiled plants, invertebrates, and vertebrates (Sheridan et al., 1997; Askins, 2000; Forrester et al., 2005; Young et al., 2007; Bertin and Rawinski, 2012; Schweitzer et al., 2011; Wagner and Metzler, 2011).

Although there are many studies documenting the importance of powerline rights-of-way for wildlife and a taxonomic array of rare and endangered species, the number of studies focused on the plant communities under transmission lines is surprisingly small. Hill et al. (1995) characterize nine plant communities under a New York TLC, focusing on which communities were more resistant to invasion by woody species; Meers and Adams (2006) report increased plant species diversity under TLCs in Australia. Only a tiny fraction of previous studies document how the vegetation of powerline ROWs compares with that of surrounding woodlands (e.g., Luken et al., 1992; Cameron et al., 1997). Rather, most previous studies of TLCs have been focused on vegetation management, and in particular the maintenance of self-perpetuating vegetation (e.g., grassland, heathland, and shrubland) that is resistant to invasion of trees (Niering and Goodwin, 1974; Dreyer and Niering, 1986; Bramble et al., 1990; Luken et al., 1992; Hill et al., 1995; Yahner and Hutnick, 2005; Clarke and White, 2008). Several studies highlight the value of powerline corridors as habitat for rare and endangered plants (Sheridan et al., 1997; Bertin and Rawinski, 2012; Tompkins, 2013). The role that powerlines play in the spread of invasive species has also received attention (Cameron et al., 1997; Merriam, 2003; Dubé et al., 2011).

In this study, we evaluate vegetation composition along a 140-km TLC segment in central New England in order to compare plant species composition and richness along powerlines with paired plots in adjacent woodlands. In addition to documenting differences between powerline and woodland plots in species composition, cover, and vegetation structure, we assess the relative prevalence of non-native invasive plants, ericaceous species, Asteraceae and other plants known to provide important food and cover for wildlife, and foodplants for host-specialized moths and butterflies (Lepidoptera) and bees (Anthophila) on and off TLCs.

2. Methods

2.1. Area of study

The study area is located in a section of a contiguous 140-km (89-mile) powerline corridor owned and maintained by Northeast Utilities (Figs. 1 and 2). Extending from northern Connecticut north into southern New Hampshire, this section is part of a larger transmission system that ties the electric generation capacity of three major electric generating facilities in New England. The southern portion of the rights-of-way is located within the Lower Connecticut River Valley and the Worcester–Monadnock Plateau, subsections within the Lower New England Ecoregion. Vegetation of this ecoregion is characterized by the predominance of Appalachian oak-pine forests. Northern plots were located in the Hillsboro Inland Hills and Plains subsection within the Vermont-New Hampshire Upland Ecoregion. This ecoregion is dominated by northern hardwood forests (Keys et al., 1995) (Fig. 1). The Connecticut rights-of-way was cleared in 1963–1964; the Massachusetts and New Hampshire sections were cleared in 1969–1970. Vegetation management in Connecticut and most of Massachusetts consists of a combination of mechanical and chemical control; north of Northfield, Massachusetts into New Hampshire, herbicides are excluded with only mowing used to maintain low vegetative cover (Northeast Utilities, 2013).

2.2. Site selection

Using utility pole numbers, twenty-seven randomly selected, paired plots were located in rights-of-way sections pre-screened to avoid wetlands, intensive agricultural use, mining, and residential/commercial development. Sites where location/permissions made access unfeasible or where woodland habitat was not present adjacent to the powerline were also rejected. A list of all plot locations, dominant plant communities, recent disturbance, and other relevant comments are given in SOM Table 1.

2.3. Data collection

At each site, two 20×50 m vegetation modules (Peet et al., 1998) were established, one within the rights-of-way and the second in adjacent woodlands; woodland plots were located at least 10 m from the TLC edge, where vegetation appeared to be uniform in structure and composition. Each module was further divided into ten 10×10 m sub-plots, three of which were randomly selected for additional sampling.

For each module, vegetation structure and dominant species were identified, and a list of all vascular plant species was tabulated. In addition, slope, aspect, topographic position, average soil texture, and soil drainage were recorded. We employed a slightly modified version of the USGS/NPS's Field Methods for Vegetation Mapping forms and protocol (USDI, 1994; http://www1.usgs.gov/vip/standards/fieldmethodsrpt.pdf). Other environmental information, such as landscape context and evidence of recent or historical disturbance, was also noted.

Within each sub-plot, all vascular plant species were recorded by strata: canopy (variable height), subcanopy (>5 m in height), tall shrub (2–5 m), short shrub (<2 m), and herbaceous layer. For each stratum, the percent cover of each species was recorded using Braun – Blanquet cover classes (Müller-Dombois and Ellenberg, 1974). A GPS unit was used to record the coordinates of the center point of each module. Plot data were entered into the USGS PLOTS database where the cover classes were converted into the mid-point of each Braun – Blanquet cover class. We refer to this numerical mean value as "mean cover" throughout the paper. Detailed plot-selection and data-collection protocols are given in supplementary materials, and all plot data have been uploaded into VegBank (http://vegbank.org/vegbank/index.jsp).

2.4. Data analysis

To compare mean species richness in powerline vs. woodland plots and among management types, we conducted a two-way ANOVA using SPSS v. 21 (IBM SPPS, 2012). Simple linear regression was used to examine species richness vs. latitude. We used EstimateS (Colwell, 2013) to construct species accumulation curves and determine the predicted number of species in both the powerline and woodland plots. Nonmetric multidimensional scaling (NMS; Sørenson distance measure, 92 iterations) was used to evaluate vegetation variation in powerline and woodland plots (McCune and Mefford, 2011). In the secondary matrix, we included plot type (woodland or powerline), management type (cut only or herbicide with limited cutting), and latitude (in decimal degrees). A two-way ANOVA determined whether plot species richness was related to the presence of disturbance and variation in soil drainage (hydrology) in the powerline plots. We compared the relative cover of non-native invasive and clonal species between powerline and woodland plots. Non-native invasives were defined using the Invasive Plant Atlas of New England species list (Mehrhoff et al., 2003). We also explored differences in the proportion of cover of clonal species (with a separate analysis focusing on *Dennstaedtia punctilobula*), tree species, and all woody species