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Use of short-rotation coppice willow crops by birds and small mammals in central New York

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ABSTRACT

As the use of short-rotation coppice willow crops increases, this vegetation type will comprise a greater extent of the landscape, yet its attendant effects on biodiversity remain poorly understood. In this study we characterized the avian and small mammal communities of willow crops that were established for phytoremediation and biomass production in industrial settling basins and compared these communities to those of surrounding areas of naturally-established perennial herbaceous-woody vegetation. Overall, we observed 33 bird species and five small mammal species in five focal sites (i.e., areas consisting of willow crops and adjacent vegetation) and 20 bird species and four small mammal species in two reference sites (i.e., areas of the settling basins without willow crops). For birds and small mammals, focal sites supported slightly greater average species richness and average abundances of all species combined than reference sites. Within focal sites, willow crops supported fewer species and similar combined abundances compared to adjacent areas. Importantly, community and individual species responses varied with the duration of time since coppicing. More small mammal species and individuals used willow crops in the year following coppicing because of their herbaceous undergrowth, while more birds tended to use older willow crops. Collectively, these results indicate that willow crops located within areas of perennial herbaceous-woody vegetation provide some benefits to bird and small mammal populations and that promoting a herbaceous layer in willow crops and maintaining multiple age classes of willows in the landscape simultaneously are likely to enhance the value of willow crops for biodiversity.

1. Introduction

Short-rotation woody crops are increasingly being used to address a range of environmental problems. They provide a carbon-neutral source of biomass for energy production [1–3]; convert wastes (e.g., wood ash and municipal waste water and sludge) into woody biomass [4,5]; are utilized for phytoremediation to remove heavy metals from soil, break down organic compounds, or contain contaminated soils via evapotranspirative reduction in the volume of leachate [4,6–9]; control soil and wind erosion; and act as living snow fences and riparian buffers [1,10]. In northern temperate areas, woody crop production has focused on willows (*Salix* spp.) [2,11]. The basic characteristic of willow production involves genetically improved plant material that is grown on open or fallow agricultural land and cultivated under a short-rotation coppice system [10]. Under this system sites are intensively prepared to control weeds and willows are planted

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in double rows as unrooted cuttings at a density of about 15,000 ha^{-1}, coppiced after the first growing season to initiate re-sprouting of multiple stems from the remaining stools, and then harvested by coppicing every 3–4 years [2,12,13]. During each rotation, the vegetation structure of the willow crops changes rapidly; within their first growing season after coppicing they change from an essentially open field to an open-canopy shrub community and by their third year they form a closed-canopy, forest-like stand with stems approaching 10-m in height.

Given that vegetation structure is an important determinant of animal distribution [e.g., [14–18]], the rapidly changing vegetation structure of willow crops as well as its novelty and increasing extent in the landscape will likely have important consequences for the structure of animal communities at local and landscape scales. Nevertheless, few studies have examined the ecological effects of this newly emerging and dynamic land-use. Of the studies that have been conducted, most have examined birds. For example, in farmland landscapes in the UK and Sweden, a diverse suite of bird species used willow crops, but only a few species showed strong preference for this vegetation type [19–24]. Further, willow crops were found to increase the abundance and diversity of birds in an area when they replaced other arable crops or improved grasslands, but not when they replaced scrub or broad-leaved vegetation types, semi-natural grasslands, or wetlands [20,22,24]. Likewise, Dhondt et al. [25,26], observed that bird species richness, nesting density, and reproductive success in willow crops in central New York State were similar to other early-successional vegetation types in the region (e.g., farmland, abandoned fields, clear cuts, and shrublands). The few studies that have investigated other taxa found that willow crops support a diverse insect community [23,27,28], provide browse for large herbivores [29], but are poor habitat for most small mammals species unless a herbaceous layer is allowed to develop [21,28,30].

The potential for willow crops to affect biodiversity suggests that their establishment in the landscape for utilitarian purposes such as biomass production could also accommodate management goals associated with biodiversity conservation. Integrating these land management goals will require knowing which species are using willow crops, how the vegetation structure of willow crops affects these species, and how the species assemblages using these systems compare to those in the vegetation types that are being replaced. To this end, we characterized the vegetation structure and avian and small mammal communities of different-aged willow crops and compared them to those of the surrounding vegetation types. Our study focused on willow crops that were planted for the dual purpose of evapotranspiration cover and biomass production on settling basins formerly used by an industrial soda ash production operation. We expected that willow crops would increase or have a negligible effect on avian and small mammal biodiversity compared to the perennial herbaceous-woody-plant communities that dominates the settling basins and that older willow crops would have greater structural complexity and thus provide greater niche differentiation and higher biodiversity.

2. Methods

2.1. Study site

The Solvay settling basins encompass about 240 ha adjacent to Onondaga Lake in the town of Camillus in Syracuse, NY (43.072 N, 76.255 W; Appendix A). From 1881 to 1986, these areas were used as the primary disposal site for the waste by-products (calcium chloride and other salts) of the production of soda ash (sodium carbonate). Following the termination of their use, successional processes have converted much of the settling basins into perennial herbaceous-woody-plant communities [31] in which *Populus deltoides* was the dominant tree and shrub. Between 2004 and 2008, five areas of the settling basins ranging in size from 0.4 to 1.8 ha were planted with fast-growing shrub willows to assess the effectiveness of this system as an evapotranspiration cap that reduces or eliminates the leaching of salts into the lake and to determine the growth rate of different willow varieties for biomass production (Table 1, Appendix A). The soils in these areas were amended with biosolids and crops were established using 25-cm long cuttings of willow from 10 clonal varieties. Plants were arranged in a double-row configuration at

Table 1 – Distribution of sampling effort among five focal sites (FS) and two reference sites (RS) in the Solvay settling basins, Syracuse, NY, 2009. Sampling within focal sites was divided among willow crops (W), adjacent control areas (C), and intervening edges (E). Reference sites were composed entirely of control areas.

			Area (ha)		Number of vegetation plots		Number of small mammal traps				Mist net hours			
Site	Last Coppiced	Age of Willows	W	C	W	C	W	E	C	Total	W	E	C	Total
FS1	2006	3	0.43	0.61	3	3	29	20	51	100	58.65	58.65	58.65	175.95
FS2	2007	2	0.44	0.46	3	3	20	25	55	100	41.17	41.17	40.33	122.67
FS3	2006	3	0.65	0.59	3	3	32	18	50	100	33.33	42.33	35.33	110.99
FS4	2009	1	1.33	1.45	3	3	31	12	57	100	36.42	36.42	36.42	109.26
FS5	2009	1	1.79	2.66	3	3	25	10	65	100	47.55	47.55	47.55	142.65
RS1	–	–	–	1.48	–	3	–	–	100	100	–	–	141.58	141.58
RS2	–	–	–	3.13	–	3	–	–	100	100	–	–	105.45	105.45