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RESEARCH NOTE

Branch Morphology of Nonnative *Elaeagnus* Shrubs and Potential Consequences for Avian Activity in Midwestern Habitats

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ABSTRACT: Invasive nonnative species of woody plants can alter landscapes in ways that are detrimental to native wildlife. We studied branch structure of invasive nonnative *Elaeagnus* shrubs (autumn and Russian olive *E. umbellata* and *E. angustifolia*) as a potential influence on native bird activity in Midwestern habitats. In a comparison to three common native woody plants, *Elaeagnus* shrubs had a finer branch and denser structure than native black cherry (*Prunus serotina*) but did not differ from natives in other characteristics tested. Further, the morphological characteristics of *Elaeagnus* branches did not appear to affect preference for perching substrate at feeders or activity of birds moving through *Elaeagnus* and native shrub areas monitored using mist nets. Thus, we concluded that any morphological changes that may occur when *Elaeagnus* shrubs invade a habitat would not negatively impact overwintering and breeding bird perching behavior or movements during the nonfruiting season.

Index terms: bird behavior, branch structure, *Elaeagnus angustifolia*, *Elaeagnus umbellata*, invasive plant

INTRODUCTION

Recent attention has been focused on the causes and consequences of the expansion of shrublands worldwide (Briggs et al. 2005; Naito and Cairns 2011). Expanding shrub cover can result in changes in the structural characteristics of vegetation (Kempf and Pickett 1981; Brantley and Young 2010) with resulting impacts on wildlife (Hudson 2000; Fleishman et al. 2003; Borgmann and Rodewald 2004). Nonnative shrub invasions can be particularly rapid and introduce potentially novel plant morphology to a system (Knopf and Olson 1984; Schmidt and Whelan 1999).

Vegetation structure can impact birds in a variety of ways. The strength and reaction force of perch substrate determines bird energy use during landing and takeoff (Bonser et al. 1999). Wild birds are known to be selective in where they perch (Castrale 1983; Layhe and Ritchison 2004) and this choice could be related to the morphology of available branches. In addition, vegetation characteristics such as spatial gaps and vegetation height influence the short-term movement of birds through habitats (Brodmann et al. 1997; Harris and Reed 2002). Structure of woody vegetation also influences nest site selection by birds. Birds select areas with stronger latticelike branching patterns, greater stem density, and overall cover (Showler et al. 2002; Dhondt et al. 2004; Schlossberg and King 2009). Thus, it appears that birds may respond to structural changes in a habitat that result from invasion by nonnative woody plants.

Elaeagnus umbellata Thunb. and *E. angustifolia* L. are old-world natives and were intentionally promoted and planted in North America in the 1960s and 1970s to provide good wildlife cover and food (Ebinger and Lehnen 1981). However, by the mid to late 1980s, there were concerns that *Elaeagnus* spp. were causing declines of native plants (Catling et al. 1997; Drake et al. 2003). Brantley and Young (2010) found that the branching structure of *Elaeagnus umbellata* differed from native shrubs in mesic shrub communities in Virginia and it is likely that it also alters habitat characteristics in other areas where it has become established. Our objectives were (1) to compare the branch structure of *Elaeagnus* spp. and native shrubs, (2) to assess if birds had a preferred branch structure of native vegetation over *Elaeagnus* spp., and (3) to determine if bird activity was lower in invaded versus noninvaded areas during the nonfruiting season.

METHODS

We examined the impacts of *Elaeagnus* spp. on birds both on the Valparaiso University campus in Porter County, Indiana, in winter 2011, and at Pierce Cedar Creek Institute (PCCI) in Barry County, Michigan, in summer 2011. The Valparaiso University campus study site included a partially wooded area with both resident and overwintering migratory bird species in abundance. The PCCI site contained a mix of deciduous forest, field, prairie, and fen habitats where *Elaeagnus* shrubs grew either as dense thickets or as single scattered plants mainly in edge habitats. The two species of *Elaeagnus* were lumped together because of similar growth form

and history as escaped wildlife plantings. The native shrubs used in comparison to *Elaeagnus* spp. were black cherry (*Prunus serotina* Ehrh.), gray dogwood *(Cornus racemosa* Lam.), and hawthorn (*Crataegus* spp.), the three most common species of similar habit in our study sites. Neither *Elaeagnus* nor the native species had ripe fruits during the time of this study.

We quantified branch structure of *Elaeagnus* and native shrubs at PCCI in full sun edge habitats. Our sampling procedure was modified from the methods used by Knopf et al. (1988) and Showler et al. (2002) in studies of bird habitat characteristics. Branch structure and deflection data were collected on 10 mature individual shrubs of each species. We established 1-m transects placed in a N-S cardinal direction horizontally through the center of each shrub. We measured the diameter and counted each dead and living woody twig within 2.5 cm of each transect. Deflection of branches was tested by measuring the force needed to deflect the first 4 cm of an individual first-order twig from its horizontal position to a 45° angle using a 50-g Pesola spring scale. Five randomly selected horizontal outer twigs of each individual shrub at breast height were assessed. The upward deflection was assumed to be a measure of the stiffness of the branch and inversely related to the amount of energy a bird needs to exert at take-off (Bonser et al. 1999). Branch measurements were averaged per individual shrub for branch density and deflection and compared among species using single-factor ANOVA with a pairwise Tukey's post-hoc test.

To assess if birds had a preferred branch structure between native and *Elaeagnus* shrubs, modified bird feeding stations were used with shrub branches as perching substrate. We first tested overwintering birds in 22 choice tests with modified bird feeders that were positioned in a partially wooded area on the Valparaiso University campus. Distal twigs approximately 20–50 cm long of *Elaeagnus* spp. and black cherry were attached in opposite horizontal orientations in place of the regular feeder perches of a cylindrical bird feeder. Black cherry was used as a representative native because it was common in the same habitat as *Elaeagnus*. Test branches were collected from local sites within a 10-km radius of the feeding area and perches were changed every day during observation so that birds did not habituate to any particular branch. At the start of each observation, the feeder was filled with sunflower seed and left for at least 15 minutes before the 30 minute observation time. The number of visits to each branch was recorded as well as the species of the bird and whether or not it ate from the feeder. A second round of choice tests was conducted on breeding birds at PCCI. Pairs of cylindrical feeders without perches were placed in *Elaeagnus* and nearby native shrubs requiring birds feeding at the feeders to perch in the first order branches of the target shrubs. This test of breeding bird preferences presented the perching substrate in a more natural way than the test with overwintering birds, but also had more variation in habitat and individual shrub growth characteristics. Differences in use of perching substrate were assessed using paired *t*-tests.

Captures of birds using mist nets were used to compare bird activity in areas with and without *Elaeagnus* shrubs in different habitats at PCCI. Three pairs of 10 × 2.5-m mist nets with 16-mm mesh were set up at one time in a particular habitat. We opened each net to trap birds for one morning (0600–0830) and one evening (1800–2100). This was repeated in five different habitats for a total sample size of 15 net pairs. The numbers of birds captured in nets set in *Elaeagnus* shrubs versus those caught in native shrub areas were compared using a Wilcoxon Signed Rank Test. All birds were released at point of capture. The non-*Elaeagnus* sites were located roughly 3–20 m away from the *Elaeagnus* sites, but in the same habitat type. We used $P < 0.05$ to indicate significant differences in all statistical tests.

RESULTS

Average density of *Elaeagnus* branches was higher and branch diameter smaller than those of black cherry, but no differences between *Elaeagnus* and hawthorn or dogwood were detected (Table 1). Branches of *Elaeagnus* shrubs ranged from 2.4 to 6.3 mm, while the larger cherry branches ranged from 5.6 to 18.0 mm in diameter. Average deflection did not differ between species and ranged from 20.4 g @ 45° angle for dogwood to 24.9 g @ 45° angle for hawthorn.

There were no differences in rate of visits to feeders in our substrate choice tests (overwintering: $t_{21} = 2.08$, $P = 0.70$; breeding: $t_{19} = 2.09$, $P = 0.65$). During winter 2011, 809 visits to *Elaeagnus* branches and 989 visits to black cherry were recorded over nine days on the Valparaiso University Campus. Birds visited feeders at a rate of 20.2 (±11.35 SD) visits/hour in *Elaeagnus* substrates and 22.5 (±11.15 SD) visits/hour for black cherry substrates. In contrast, breeding birds at PCCI visited feeders 21 times in *Elaeagnus* substrates and 18 times to native substrates over a 10-day period. Rates of bird visits were 0.52 (±0.68 SD) and 0.45 (±0.78 SD) birds/hour respectively.

Fifty-two adult breeding birds were caught in over 100 trapping hours. Twenty-six birds were captured in each type of area, *Elaeagnus* and native vegetation, with two recaptures in the *Elaeagnus* areas. We caught 0 to 5 birds per mist net and found no differences in the number of birds caught between *Elaeagnus* and native shrub locations ($n = 15$, $T_{(10)} = 23.5$, $P > 0.05$). We caught representatives of 22 species (Table 2), with nine of those captured in both *Elaeagnus* and native shrub areas. Sample sizes were too small to assess differences within any one species or in species diversity.

DISCUSSION

We found no evidence that invasion by *Elaeagnus* spp. is likely to alter bird perching behavior during the nonfruiting season. Although one native species of shrub differed in branch morphology from that of *Elaeagnus,* we did not find that this, or any other undetected differences in branch morphology, resulted in changes in bird activity. Thus, although it is possible that when invasive nonnative *Elaeagnus* shrubs occupy a landscape the quality of woody substrate available for birds to perch in or move through may change, it appears that this potential change does

Table 1. Branch structure characteristics for four woody species measured along horizontal transects through the middle of each plant (density and diameter) or at breast height (deflection) at PCCI, Barry County, Michigan, during summer 2011.

	Elaeagnus		Black cherry		Dogwood		Hawthorn				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*F*	df	*P*
Density (branch/transect)	6.1	1.45	3.1[a]	1.59	5.5	2.84	5.1	1.45	3.24	3,36	0.01
Diameter (mm/branch)	3.8	1.06	8.8[a]	3.86	4.3	3.56	5.7	4.67	4.309	3,35[b]	0.02
Deflection (g/45° angle)	22.2	5.4	23.7	7.57	20.4	5.84	24.9	9.33	0.719	3,36	0.55

[a] Significantly different from *Elaeagnus* branches.
[b] One transect through black cherry contained zero branches.

not translate into preference or avoidance of *Elaeagnus* shrubs compared to native woody vegetation.

In choice tests using feeding stations, local birds showed no preference for, or avoidance of, *Elaeagnus* over native woody vegetation for perching. These experiments focused on seed-eating species such as finches and sparrows because the bait used in the feeders was sunflower seeds and not insects. Most small birds using shrubby woody vegetation in our study sites were probably insectivores rather than granivores. However, regardless of diet, most are still small passerines with similar foot structures and it is likely that perching substrate requirements would be similar across species. Thus, we believe that our feeder test results accurately portray a lack of preference for perching in specific shrub species.

All of our data were collected during the nonfruiting season for *Elaeagnus* and other shrubs. Many birds use the fruit of *Elaeagnus* shrubs and may greatly enhance the spread of these shrubs in North America through seed dispersal (Lafleur et al. 2007). Thus, the presence of *Elaeagnus* shrubs in the landscape could change bird presence and behavior during the fruiting season, but this was outside the scope of our study. Although we did not examine nest site selection, success, or predation rates, our results suggest that *Elaeagnus* shrubs are not avoided by overwintering or breeding native birds at least for perching or movement. Some have suggested that landscape changes caused by invasive nonnative plants could especially impact migrant birds (Hudson 2000). It is possible that unique structural characteristics of *Elaeagnus* shrubs have an impact on migrating birds resting in our study areas, but we did not test this. In addition, other changes resulting from *Elaeagnus* invasion, including increased fruit availability or alterations of insect abundance, should be studied before making a definitive conclusion that invasions do not impact native resident and migratory birds in the landscape.

Current and future increases in nonnative shrub abundance, especially in prairie and

Table 2. Species and number of birds captured in *Elaeagnus* shrubs compared to native vegetation at PCCI, Barry County, MI, during the summer of 2011.

Bird species	Number of captures	
	Elaeagnus	Native vegetation
Common yellowthroat (*Geothlypis trichas* Linnaeus)	4	7
Gray catbird (*Dumetella carolinensis* Linnaeus)	4	1
House wren (*Troglodytes aedon* Vieillot)	3	4
American robin (*Turdus migratorius* Linnaeus)	2	2
Black-capped chickadee (*Poecile atricapillus* Linnaeus)	2	0
Indigo bunting (*Passerina cyanea* Linnaeus)	2	1
Ruby-throated hummingbird (*Archilochus colubris* Linnaeus)	2	1
Black-billed cuckoo (*Coccyzus erythropthalmus* Wilson)	1	0
Blue-winged warbler (*Vermivora pinus* Linnaeus)	1	0
Eastern bluebird (*Sialia sialis* Linnaeus)	1	1
Eastern towhee (*Pipilo erythrophthalmus* Linnaeus)	1	0
Ovenbird (*Seiurus aurocapillus* Linnaeus)	1	0
Scarlet tanager (*Piranga olivacea* Gmelin)	1	0
Song sparrow (*Melospiza melodia* Wilson)	1	1
Wood thrush (*Hylocichla mustelina* Gmelin)	1	0
Yellow warbler (*Dendroica petechia* Linnaeus)	1	1
Northern cardinal (*Cardinalis cardinalis* Linnaeus)	0	2
American goldfinch (*Spinus tristis* Linnaeus)	0	2
Chipping sparrow (*Spizella passerina* Bechstein)	0	1
Eastern phoebe (*Sayornis phoebe* Latham)	0	1
Field sparrow (*Spizella pusilla* Wilson)	0	1
Rose-breasted grosbeak (*Pheucticus ludovicianus* Linnaeus)	0	1

savanna habitats, clearly have potential ecological consequences (Drake et al 2003; Briggs et al. 2005). However, predicting the direct impacts of these invasions on birds is difficult (Catling 2005; Wilcox and Beck 2007). Our results suggests that invasive nonnative shrubs do not change avian activity in invaded habitat, but more research is needed on use of these shrubs during the fruiting season, especially by migratory birds, to better inform management decisions regarding *Elaeagnus* in the landscape (Whelan and Dilger 1992; Zavaleta et al. 2001).

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Heather Herakovich and Marcy DeVries were both undergraduate students at Valparaiso University at the time of this study. They both graduated in the spring of 2012 with Bachelor of Science degrees in biology. Heather is now a graduate student at Northern Illinois University. As a Master's student, she studied how grassland bird density and success changed with the immediate reintroduction of bison at the Nachusa Grasslands. She will pursue her PhD with research on how bison influence nest density and success over time. Marcy now resides in central Michigan and works on artificial pond management.

Laurie Eberhardt is an Associate Professor of Biology at Valparaiso University. She teaches ecology, field biology, and animal behavior and involves students in undergraduate research whenever possible. Her research interests include the interactions between plants and animals, with special focus on impacts of nonnative species.

LITERATURE CITED

Bonser, R.H.C., A.P. Norman, and J.M.V. Rayner. 1999. Does substrate quality influence take-off decisions in common starlings? Functional Ecology 13:102-105.

Borgmann, K.L., and A.D. Rodewald. 2004.

Nest predation in an urbanizing landscape: The role of exotic shrubs. Ecological Applications 14:1757-1765.

Brantley, S.T., and D.R. Young. 2010. Linking light attenuation, sunflecks, and canopy architecture in mesic shrub thickets. Plant Ecology 201:225-236.

Briggs, J.M., A.K. Knapp, J.M. Blair, J.L. Heisler, G.A. Hoch, M.S. Lett, and J.K. McCarron. 2005. An ecosystem in transition: Causes and consequences of the conversion of mesic grassland to shrubland. BioScience 55:243-254.

Brodmann, P.A., H-U. Reyer, and B. Baer. 1997. The relative importance of habitat structure and of prey characteristics for the foraging success of water pipits (*Anthus spinoletta*). Ethology 103:222-235.

Castrale, J.S. 1983. Selection of song perches by sagebrush-grassland birds. Wilson Bulletin 95:647-655.

Catling, P.M. 2005. Effects of invasive alien plants on birds: Some examples from North America. Biodiversity 6:30-39.

Catling, P.M., M.J. Oldham, D.A. Sutherland, V.R. Brownell, and B.M.H. Larson. 1997. The recent spread of Autumn-olive, *Elaeagnus umbellata*, into Southern Ontario and its current status. Canadian Field Naturalist 111:376-380.

Dhont, A.A., P.H. Wrege, K.V. Sydenstricker, and J. Cerretani. 2004. Clone preference by nesting birds in short-rotation coppice plantations in central and western New York. Biomass and Bioenergy 27:429-435.

Drake, S.J., J.F. Weltszin, and P.D. Parr. 2003. Assessment of non-native invasive plant species on the United States Department of Energy Oak Ridge National Environmental Research Park. Castanea 68:15-30.

Ebinger, J., and L. Lehnen. 1981. Naturalized autumn olive in Illinois. Transactions of the Illinois State Academy of Science 111:376-380.

Fleishman, E., N. McDonal, R. MacNally, D.D. Murphy, J. Walters, and T. Floyd. 2003. Effects of floristics, physiognomy and non-native vegetation on riparian bird communities in a Mojave Desert watershed. Journal of Animal Ecology 72:484-490.

Harris, R.J., and J.M. Reed. 2002. Behavioral barriers to non-migratory movements of birds. Annales Zoologici Fennici 39:275-290.

Hudson, S.E. 2000. Avian Use of Riparian Areas in the Mid-Columbia River Basin during Fall Migration. Master's thesis, University of Idaho, Moscow.

Kempf, J.S., and S.T.A. Pickett. 1981. The role of branch length and angle in branching pattern of forest shrubs along a successional gradient. New Phytologist 88:111-116.

Knopf, F.L., and T.E. Olson. 1984. Naturalization of Russian-olive: Implications to Rocky Mountain wildlife. Wildlife Society Bulletin 12:289-298.

Knopf, F.L., J.A. Sedgwick, and R.W. Cannon. 1988. Guild structure of a riparian avifauna relative to seasonal cattle grazing. Journal of Wildlife Management 52:280-290.

Lafleur, N.E., M.A. Rubega, and C.S. Elphick. 2007. Invasive fruits, novel foods, and choice: And investigation of European starling and American Robin frugivory. The Wilson Journal of Ornithology 119:429-438.

Leyhe, F.E., and G. Ritchison. 2004. Perch sites and hunting behavior of red-tailed hawks (*Buteo jamaicensis*). Journal of Raptor Research 38:19-25.

Naito, A.T., and D.M. Cairns. 2011. Patterns and processes of global shrub expansion. Progress in Physical Geography 35:423-442.

Schlossberg, S., and D.I. King. 2009. Effects of invasive woody plants on avian nest site selection and nesting success in shrublands. Animal Conservation 13:286-293.

Schmidt, K.A., and C.J. Whelan. 1999. Effects of exotic *Lonicera* and *Rhamnus* on songbird nest predation. Conservation Biology 13:1502-1506.

Schowler, D.A., I.M. Cote, and C.G. Jones. 2002. Population census and habitat use of Rodrigues warbler *Acrocephalus rodericanus*. Bird Conservation International 12:211-230.

Whelan, C.J., and M.L. Dilger. 1992. Invasive, exotic shrubs: A paradox for natural area managers? Natural Areas Journal 12:109-110.

Wilcox, J., and C.W. Beck. 2007. Effect of *Ligustrum sinense* Lour. (Chinese privet) on abundance and diversity of songbirds and native plants in a southeastern nature preserve. Southeastern Naturalist 6:535-550.

Zavaleta, E.S., R.J. Hobbs, and H.A. Mooney. 2001. Viewing invasive species removal in a whole-ecosystem context. Trends in Ecology and Evolution 16:454-459.