

The Impacts of an Invasive Shrub, Autumn Olive (*Elaeagnus umbellata*), on Behavior and Nesting Success of American Robins (*Turdus migratorius*) and Northern Cardinals (*Cardinalis cardinalis*)

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Abstract

Invasive shrubs can significantly impact multiple layers of native ecosystems. The purpose of this study was to examine the impacts of Autumn Olive, an invasive shrub throughout the Midwest, on two specific species of the bird community, American Robins (*Turdus migratorius*) and Northern Cardinals (*Cardinalis cardinalis*) at PCCI. Impacts of Autumn Olive invasion on bird activity was evaluated using activity time budgets performed during the early and late periods of the breeding season. Activity time budgets revealed a significant difference between Autumn Olive cover available and time spent in Autumn Olive. Impacts on nesting behavior and success was evaluated through nest tracking and territory vegetation analysis. A total of 18 robin nests, one of which was placed in Autumn Olive, and 3 cardinal nests, none of which were placed in Autumn Olive, were tracked throughout the breeding season. A total of 14 robin and 3 cardinal territories were mapped and analyzed for vegetation cover. Vegetation analysis showed no difference between amount of Autumn Olive in the nest quadrat and the territory average. These results suggest that birds avoid perching and nesting in Autumn Olive, although our nest sample size was low. There were no significant differences between Autumn Olive density throughout the territory and Autumn Olive density around the nest or overall territory size. Thus, while our data support the hypothesis that birds avoid Autumn Olive during the breeding season, we cannot determine if this translates into lower breeding success for these birds due to low sample size. However, our results do suggest that management of Autumn Olive infestations may have positive impacts on native bird species.

Introduction

The impacts of exotic plants on native communities are a major focus of current ecological research. These impacts can be positive by providing additional food and cover in an existing habitat or negative by competitively excluding native plants and subsequently, animals that depend on these natives (Zaveleta et al 2001). For example, the fragmentation and alteration of native habitats that occurs when exotic species become invasive has been implicated in many recent declines in bird populations (Catling 2005). However, because many invasive plants are only recently invading new areas, specific information about how particular invasive plants impact native communities is often lacking. Data on these impacts provides essential information for designing management plans for invasive plants (Sogge et al 2008). The non-native shrub Autumn Olive (*Elaeagnus umbellata*), originally

planted at the Pierce Cedar Creek institute (PCCI) to benefit wildlife habitat (Hovey 2008), has now spread over large areas of PCCI (Travis and Wilterding 2005).

Recent research conducted at PCCI to investigate the impacts of Autumn Olive on the local plant communities has revealed that Autumn Olive's physiology allows it to successfully invade both forest understory and field habitats (Edwards and Dornbos 2008, Hesseling and Dornbos 2007, Ritsema and Dornbos 2006). In 2008, Krintz and Eberhardt found that Autumn Olive may have a negative impact on the bird community at PCCI as evidenced by reduced bird activity in Autumn Olive compared to native shrubs during the non-fruiting season.

The two specific species were chosen for this research project, the Northern Cardinal (*Cardinalis cardinalis*) and the American Robin (*Turdus migratorius*). Both species are monogamous birds, except for rare instances of polygyny among Northern Cardinals, and are common throughout large regions of North America. American Robin nests are found in a variety of covered places, including deciduous trees, evergreens, shrubs, road banks, and residential structures and are usually less than 3 meters from the ground (James and Sallabanks 1999). Northern Cardinal nests are often found wedged between forked branches of small trees or shrubs. Nest predators for both species include small mammals, snakes, and other birds (Halkin and Linville 1999).

Both species have been subjects of recent studies concerning the impact of exotic shrubs on breeding success. Schmidt and Whelan (1999), at Morton Arboretum in Illinois, found that nests of American Robin (*Turdus migratorius*) suffered higher predation rates when placed in two exotic shrubs (*Lonicera* and *Rhamnus*) possibly due to branch structure. In addition, Borgmann and Rodewald (2004) found that in rural landscapes in Ohio, Northern Cardinal nest substrate did not impact nest success; however in more urban landscapes, nesting in non-native shrubs negatively impacted Cardinals as observed through higher predation rates.

While Borgmann and Rodewald (2004) found that invasive shrubs do not impact nest success in rural areas, recent studies conducted at PCCI indicated that invasive shrubs may have a negative effect on bird communities (Krintz and Eberhardt 2008). The results of these studies appear to contradict one another. Therefore, the purpose of this study was to determine the impact of Autumn Olive around the nest and in the territory on the activity and breeding success of both species during the non-fruiting season at PCCI, a rural habitat.

Methods

a. Overview

This study involved locating and mapping nests and territories, tracking nest predation and success, and conducting two rounds of activity time budgets. Nests and territories were located and monitored over the entire PCCI property in Barry County, which includes a variety of habitats, including deciduous forest, prairie, wetland, and shrubby field.

Wilcoxon Signed-Rank tests and Sign tests were used on all paired data.

b. Location and mapping of nests and territories

Nests were located throughout the PCCI property and mapped using GPS points and Google Earth. A total of 14 robin nests and 3 cardinal nests were tracked to either success or failure. A successful nest was defined as a nest in which one nestling successfully fledged. These nests were located by observing individual pairs for behaviors indicating a nest in the area. Once a nest was located, it was checked every 1 to 3 days to determine its stage and fate.

Territories were also evaluated by observation of bird behavior for individual pairs, including observation of feeding locations, interaction with neighboring pairs, aggressive displays, singing, and other behaviors. Four GPS points were taken at the rough corners of the territory. These points were also put in Google Earth to help evaluate territory size. Territory size of individual pairs was then compared to the average number of Autumn Olive, determined when conducting vegetation analysis (see part c) for the territory, using a Spearman Rank Correlation. A nest was deemed successful if one young successfully fledged from the nest.

c. Vegetation analysis

After each nest had either failed or successfully fledged young, a detailed examination of the vegetation around the territory was conducted as well. A randomly placed 100m transect was run through the area, and vegetation was analyzed every 20m in circular 5m quadrats along a 100m transect. Measurements used in statistical analysis included: number of Autumn Olive (≥ 3 m in height and in width and distance to nearest Autumn Olive).

A detailed examination of the vegetation around the nest was also conducted in a similar manner, using the nest as the center of the 5m quadrat. In addition, cause of any predation, if applicable, and nest substrate were recorded.

The average number of Autumn Olive in each nest quadrat was compared to the average number of Autumn Olive throughout the corresponding territory using a Wilcoxon Signed-Rank test for American Robins. The average distance from the nest to the nearest Autumn Olive was determined for both species.

d. Activity time budgets

Activity time budgets were collected in two rounds, early-breeding season (May 26th to June 18th) and late-breeding season (July 7th to July 17th) when Autumn Olive was not yet fruiting. Individual birds were tracked for 3 – 10 minutes, recording sex, percent Autumn Olive in the area, time spent in Autumn Olive, number of perches in Autumn Olive, time spent in native shrubs, number of perches in native shrubs, and activities. A total of 25 American Robin time budgets and 18 Northern Cardinal time budgets were collected. Following each time budget observation, the percent Autumn Olive cover was assessed for the area each bird had just used.

A Wilcoxon Signed-Rank test was used to compare the percent of Autumn Olive in the area to the percent time spent in Autumn Olive. The two species were evaluated separately.

Results

a. Location and mapping of nests and territories

Of 23 nests located (Fig. 1), only one pair of American Robins nested in Autumn Olive; the singular nest in Autumn Olive experienced predation. Of 4 Northern Cardinal nests located, none were found in Autumn Olive.



Figure 1. Map of American Robin Nests (White) and Northern Cardinal Nests (Pink)

The most common substrate for American Robins was buildings (Table 1), and the most common substrate for Northern Cardinals was Multiflora Rose (*Rosa*

multiflora) (Table 2). Table 1 lists all substrates where American Robin nests were found. Table 2 lists all substrates where Northern Cardinal nests were found.

Table 1. Substrates and Fates for American Robin Nests

Substrate	Number of Nests	Number of Successful Nest	Number of Failed Nests	Number With Unknown Fates
Building	3	3	0	0
American Beech	1	1	0	0
Boxelder	2	1	1	0
Hawthorne	2	1	1	0
Tamarack	2	2	0	0
Autumn Olive	1	0	1	0
Black Ash	1	1	0	0
Black Cherry	1	1	0	0
Blue Beech	1	0	0	1
Clone of Dogwood	1	0	1	0
Elm	1	1	0	0
European Birch	1	0	0	1
Sugar Maple	1	0	1	0

Table 2. Substrates and Fates for Northern Cardinal Nests

Substrate	Number of Nests	Number of Successful Nest	Number of Failed Nest	Number With Unknown Fates
Multiflora Rose	2	1	1	0
Red Cedar	1	0	0	1
White Cedar	1	0	0	1

b. Vegetation analysis

The average number of Autumn Olive per nest area was 1.71 (± 3.30) for American Robins and 0 for Northern Cardinals. The average number of Autumn Olive for an individual territory was 1.24 (± 1.64) for American Robins and 2.27 (± 2.90) for Northern Cardinals. A comparison of the average number of Autumn Olive in each nest quadrat to the average number of Autumn Olive throughout a territory revealed no difference between the density of Autumn Olive around the nest and throughout the territory for American Robins ($T=27.5$, $N=10$, $p>0.05$) (Fig. 2).

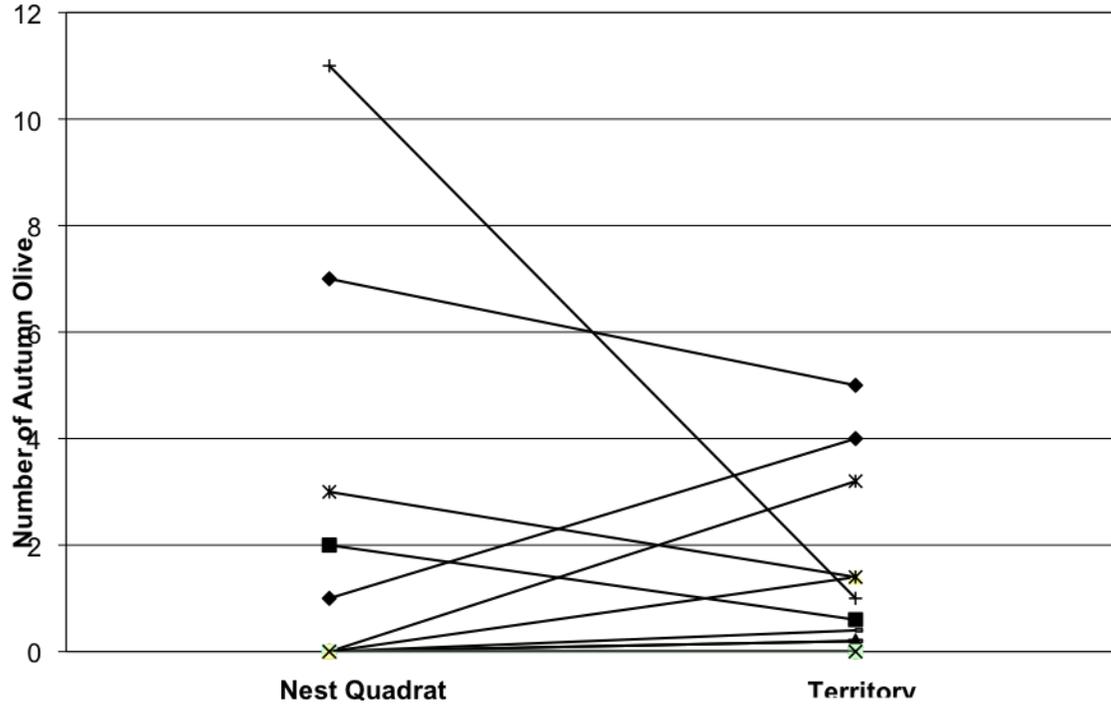


Figure 2. Number of Autumn Olive in an American Robin Nest Quadrat vs. number of Autumn Olive in the Corresponding Territory

A Wilcoxon Signed-Rank test was not performed on Northern Cardinal nest quadrat and territory averages due to low sample size (Table 3). For both species, a Spearman Rank Correlation test was performed to compare average number of Autumn Olive per random quadrat to corresponding time territory size. No correlation was found for both American Robins ($r_s = -0.17$, $N = 12$, $p > 0.05$) and Northern Cardinals ($r_s = -0.01$, $N = 6$, $p > 0.05$).

Table 3. Vegetation Analysis of Number of Autumn Olive in Nest Quadrat to Average Number of Autumn Olive in Territory.

Northern Cardinals Transect	# of Autumn Olive	
	Nest Quadrat	Territory Average
1	0	0.2
2	0	5.6
3	0	1

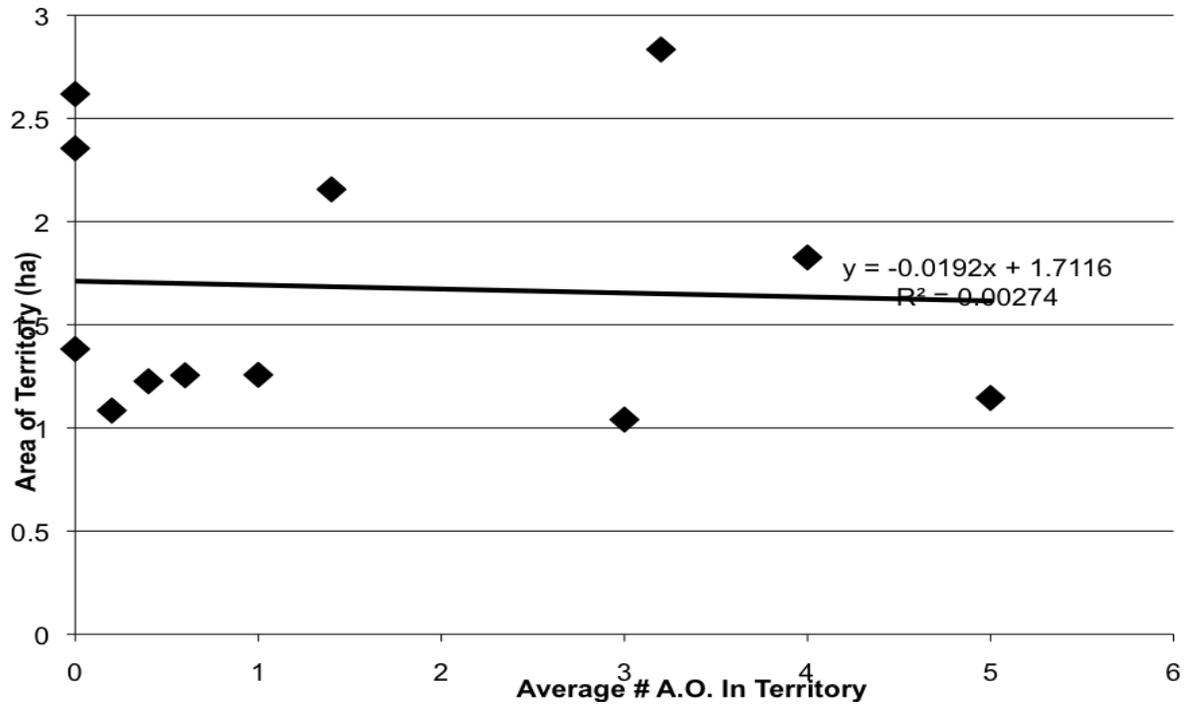


Figure 3. Area of a territory vs. average number of Autumn Olive for the territory for American Robins.

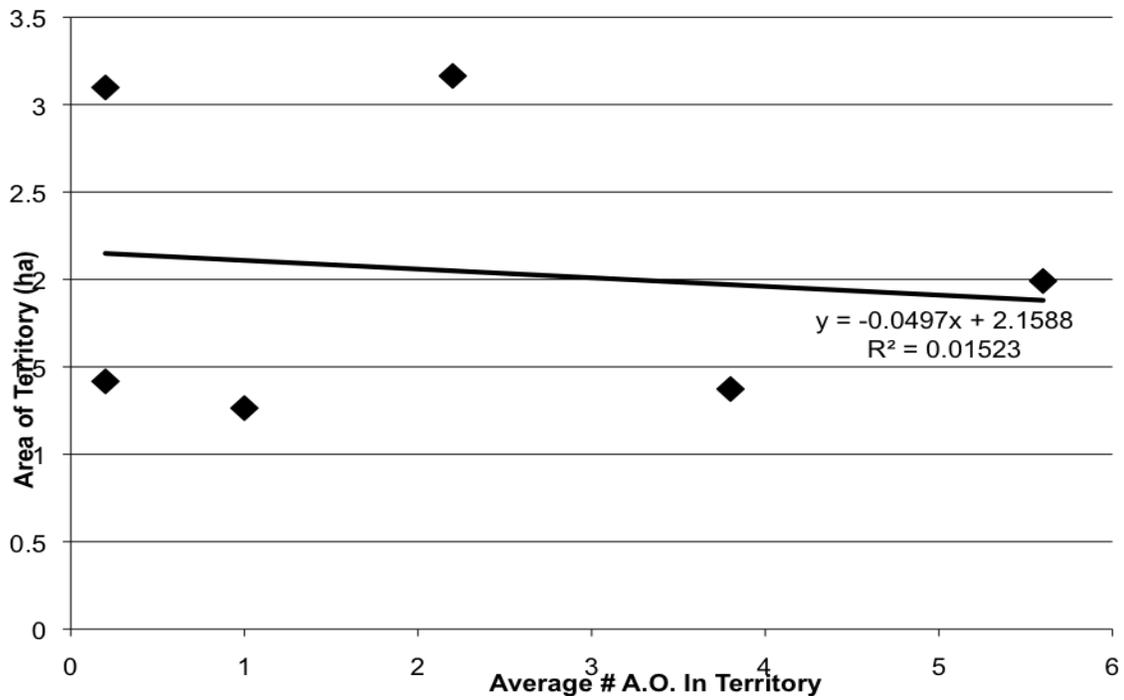


Figure 3. Area of a territory vs. average number of Autumn Olive for the territory for Northern Cardinals.



Figure 3. Map of territories for American Robins (white) and Northern Cardinals (red).

c. Activity Time Budgets

Activity time budgets for both species (see Table 4) revealed a significant difference between the percent of Autumn Olive in the area to the percent time spent in Autumn Olive for both American Robins ($T=7$, $N=25$, $p<0.05$) and Northern Cardinals ($T=0$, $N=18$, $p<0.05$).

Table 4. Early and Late Breeding Season Activity Time Budgets.

Northern Cardinal	Time in A.O. (sec)	Total Time (sec)	% Time in A.O.	% A.O. Cover
1	0	245	0.0	5
2	0	314	0.0	10
3	0	190	0.0	5
4	0	420	0.0	15
5	0	600	0.0	75
6	0	421	0.0	5
7	0	375	0.0	30
8	0	234	0.0	30
9	146	540	27.0	50
10	0	421	0.0	26
11	0	465	0.0	7
12	0	295	0.0	30
13	0	234	0.0	2
14	0	307	0.0	5
15	0	253	0.0	25
16	0	600	0.0	30
17	71	361	19.7	70
18	0	342	0.0	17
American Robin				
1	0	572	0.0	30
2	0	335	0.0	5
3	0	540	0.0	5
4	0	285	0.0	30
5	0	426	0.0	75
6	0	355	0.0	45
7	0	409	0.0	1
8	0	330	0.0	1
9	0	301	0.0	1
10	0	308	0.0	10
11	61	326	18.7	10
12	0	555	0.0	50
13	0	404	0.0	15
14	0	440	0.0	10
15	0	418	0.0	20
16	0	349	0.0	20
17	0	263	0.0	50
18	0	600	0.0	60
19	0	600	0.0	30
20	0	465	0.0	7
21	0	355	0.0	15
22	0	284	0.0	40
23	0	242	0.0	50
24	0	342	0.0	45
25	0	402	0.0	45

The average percent time spent in Autumn Olive for American Robins was 0.62%, compared to 26.80% area Autumn Olive density. The average percent time spent in Autumn Olive for Northern Cardinals was 3.27%, compared to 24.28% area Autumn Olive density (Fig. 3). During the 3-5 minute time budget observations, both robins and cardinals moved around to various perches and performed a variety of behaviors. Areas used by individual birds and subsequently assessed ranged from 500-1500 m².

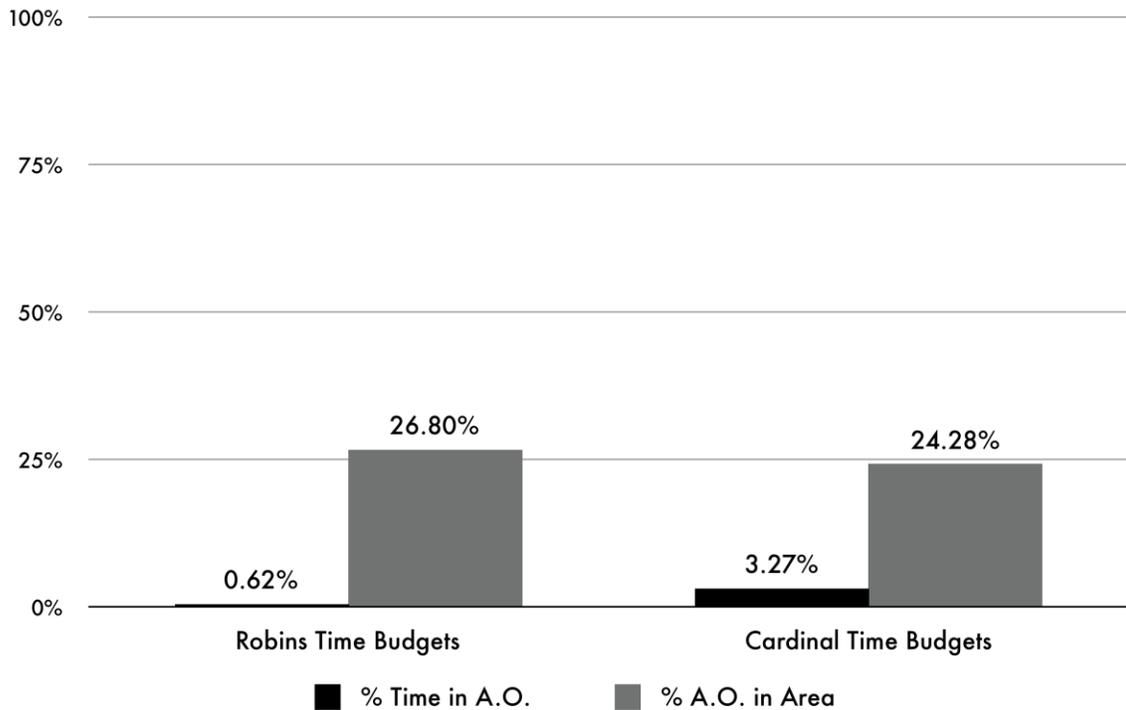


Figure 3. Percent Time in Autumn Olive vs. Percent Autumn Olive in Area

Discussion

Our study showed that both American Robins and Northern Cardinals avoid Autumn Olive during daily activities. Sample sizes were too small to indicate whether nests placed in Autumn Olive suffer higher predation. However, nest substrate data indicates that both species may avoid nesting in Autumn Olive, although further observation is needed. We recommend extending this study over many summers to determine if both species avoid nesting in Autumn Olive and/or show a preference for specific substrates. Results indicate no significant difference between the number of Autumn Olive in each nest quadrat and the average number of Autumn Olive in randomly selected quadrats of the corresponding territories.

a. Location and mapping of nests and territories

The low percent of nests found in Autumn Olive may reveal that both American Robins and Northern Cardinals preferentially avoid nesting in Autumn

Olive at PCCI. We recommend a multi-year study to enable large enough sample sizes to test the hypothesis that Autumn Olive as a nest substrate reduces nesting success for both robins and cardinals.

Although not a focus of this study, our findings suggest that Northern Cardinals favor nesting in and around high density Multiflora Rose. The effects on breeding success of Multiflora Rose, as well as other invasive plants, should be examined for both Northern Cardinals and American Robins.

b. Vegetation analysis

Because statistical test revealed no difference between the number of Autumn Olive in the nest quadrat compared to the territory average we were unable to determine whether Autumn Olive density has an impact of nesting success. The lack of a significant difference between nest quadrat density and territory density is surprising compared to the significantly reduced bird activity in Autumn Olive and may be a result of the widespread distribution of Autumn Olive at PCCI. We suggest a repeat of vegetation analysis with a larger sample size.

An analysis of territory size to average number of Autumn Olive per randomly selected quadrat revealed no significant difference. We suggest continuing collection of data to expand sample size.

c. Activity Time Budgets

Because of the significant difference between percent of time spent in Autumn Olive and percent Autumn Olive present, birds may be avoiding Autumn Olive. It is expected that if birds were randomly choosing shrubs that the two values would be roughly equivalent. We suggest further data collection to increase the sample size of activity time budgets, especially for Northern Cardinals, which showed a slightly less aversion to Autumn Olive.

These results indicate that continued invasion of Autumn Olive in meadow habitat and forest understory at PCCI may have a negative impact on daily bird activity. Although there was no significant difference between the number of Autumn Olive in each nest quadrat and the average number of Autumn Olive in randomly selected quadrats of the corresponding territories, an examination of nest substrate indicates that both species may be avoiding nesting in Autumn Olive; a larger sample size over many breeding seasons is needed to confirm this observation.

Although both American Robins and Northern Cardinals are abundant in the PCCI area, the negative impact of Autumn Olive on daily activity may expand to other species; this would present a serious a problem for nature preserves looking to attract birdwatchers. Further research is needed to continue to expand the body of knowledge on the effects of Autumn Olive's effect on the breeding success and activity of the various members of the local bird community. This knowledge will help to improve management of invasive shrubs.

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Literature Cited

Borgman, KL and AD Rodewald. 2004. Nest Predation In An Urbanizing Landscape: The Role of Exotic Shrubs. *Ecological Applications*. 14(6): 1757-1765

Catling, PM. 2005. Effects of invasive alien plants on birds: some examples from North America. *Biodiversity* 6:30-39

Edwards, K and D Dornbos. 2008. Characterization of the competitiveness of autumn olive in a mature forest. URGE research project. PCCI.

Hesselink, R. and D. Dornbos 2007. Characterization of the physiological competitiveness of autumn olive in meadow and forest environments. URGE research project. PCCI.

Halkin, SL and SU Linville. Northern Cardinal. In: Gill FB, Poole AF, Stettenheim P, editors. *The Birds of America*. Vol. 11. Philadelphia: The Academy of Natural Sciences of Philadelphia; 1999. No. 440.

Hovey J 2008. A landscape history of Pierce Cedar Creek Institute from pre-Columbian times to the present. URGE research project. PCCI.

James, FC and R. Sallabanks. American Robin. In: Gill FB, Poole AF, Stettenheim P, editors. *The Birds of America*. Vol. 12. Philadelphia: The Academy of Natural Sciences of Philadelphia; 1999. No. 462.

Krintz M, and L Eberhardt. 2008. The effects of autumn olive (*Elaeagnus umbellata*) on breeding bird nest predation and activity at Pierce Cedar Creek Institute. URGE research project. PCCI.

Ritsema MR, and DL Dornbos. 2006. Characterization of the photosynthetic competitiveness of autumn olive (*Elaeagnus umbellata*). URGE research project. PCCI.

Schmidt KA, and CJ Whelan. 1999. Effects of exotic *Lonicera* and *Rhamnus* on songbird nest predation. *Conservation Biology* 13:1502-1506.

Sogge MK, SJ Sferra, and EH Paxton. 2008. *Tamarix* as habitat for birds: implications for riparian restoration in the southwestern United States. *Restoration Ecology*. 16:146-154.

Travis J, and J Wilterding. 2005. Assessment of autumn olive (*Elaeagnus umbellata*) population at Pierce Cedar Creek. URGE research project. PCCI.

Zavaleta ES, RJ Hobbs, and HA Mooney. 2001. Viewing invasive species removal in a whole-ecosystem context. *Trends in Ecology and Evolution* 16:454-459