The Effects of Autumn Olive (*Elaeagnus umbellata*) on Breeding Bird Nest Predation and Activity at Pierce Cedar Creek Institute

October 3, 2008
Megan Krintz, student
Dr. Laurie Eberhardt,Associate Professor of Biology
Department of Biology, Valparaiso University
1610 Campus Drive East

Abstract

Autumn Olive (*Elaeagnus umbellata*) is of high concern as an invasive plant, as it has now spread to every U.S. state. The purpose of this study was to gain a better understanding of how Autumn Olive changes a community, especially through changes in bird nesting and activity. In the first part of this study, Autumn Olive nest predation rates (in both raised and ground nests) were compared to predation rates in native shrubs using artificial nests and quail eggs. Autumn Olive did not show higher predation rates in either raised or ground nest categories, though the type of predation event differed greatly between categories. A natural nest census was performed to indicate bird nesting preferences, but yielded no visible nests in the late summer. The second part of this study investigated bird activity in Autumn Olive by measuring arthropod availability and bird censuses. Comparative arthropod availability was studied via netting flying insects, trapping flying insects on flypaper, and branch beating to count crawling arthropods. Flypaper showed a significantly greater amount of flying insects on autumn olive overall and in early August, but the two other tests showed no difference. Bird activity in high-density Autumn Olive areas was measured by paired early-morning point counts, and bird activity in focal Autumn Olive was measured by daytime point pairs. While the early-morning point counts revealed no difference, a significantly greater number of birds were found native shrubs during the daytime than in Autumn Olive. These results suggest that birds may prefer native shrubs over Autumn Olive, even though Autumn Olive may offer a higher amount of insect food availability than the native environment. Given these results, Autumn Olive is unlikely to have an overall significant effect on the bird community at PCCI in the non-fruiting season.

Introduction

Autumn Olive is only one of a vast amount of invasive plant species that impact ecosystems in the United States. According to an article by P.M. Catling (2005), invasive plants in America are spreading by a rate of 14 million acres a year, and the rate is increasing. This means that ecologists must work quickly to understand exactly what impacts invasive species have on the environment in order to devise appropriate management strategies. Specifically, ecologists want to know the impact that these plants have on bird populations, because birds are indicators of the state of the environment (Catling 2005).

Autumn olive was originally introduced to the United States in the 1970's and 80's intentionally, to benefit wildlife because it supposedly provided superior food and cover; it soon became uncontrollable and invasive (Catling 2005). It is a shrub or small tree that usually grows in Asia, with a fruiting period that begins in the late summer and persists to midwinter. Autumn olive reportedly attracts a number of birds that use it for food and cover, including the Ruffed Grouse (*Bonasa umbellus*), Northern Bobwhite (*Colinus virginianus*), Mourning Dove (*Zenaida macroura*), American Robin (*Turdus migratorius*), Northern Cardinal (*Cardinalis cardinalis*),

Fox Sparrow (*Passerella iliaca*), and Song Sparrow (*Melospiza melodia*), and it is ostensibly also a good nesting site (DeGraaf 2002).

Previous research in the field of invasive plants' impact on bird nesting predation and cover has shown contradictory results. For example, according to a study by Finch and Stoleson (2001), the Mourning Dove (*Zenaida macroura*) and the Yellow-breasted Chat (*Icteria virens*) preferentially placed nests in Russian olive (*Elaeagnus angustifolia*), an invasive species in the same genus as autumn olive; nesting success was similar in Russian olive and a native species. However, in another study by Gazda et al. (2002), duck nesting success varied inversely with the presence of Russian olive. These results and others show that the impacts of invasive species on the environment are quite complicated; some birds may benefit while others do not, or bird biodiversity as a whole may change. Invasive species are also known to reduce biodiversity and "have been implicated in almost half of recent bird extinctions" (Catling 2005). More research is needed to enhance our understanding of invasive species' impacts, what is happening to reduce bird populations and why.

The aim of this study was to identify the impacts of autumn olive on nest predation and activity on Pierce Cedar Creek Institute (PCCI) property.

Methods

General Methods

Pierce Cedar Creek Institute (PCCI) of Barry County, Michigan, is a mixed landscape of deciduous forest and prairie. In 2005, about 37 percent of the area north of Cloverdale Road contained Autumn Olive, while about 21 percent of the area south of Cloverdale Road contained Autumn Olive; 14 percent of the northern section was estimated at over half Autumn Olive coverage (Travis and Wilterding 2005).

The focal Autumn Olive and native shrubs used in this study were mature plants at least 1.5m tall. The native shrubs were flowering dogwood (*Cornus florida*), wild black cherry (*Prunus serotina*), black ash (*Fraxinus nigra*), pricklyash (*Zanthoxylum americanum*), and northern spicebush (*Lindera benzoin*). Autumn Olive and native shrubs were in a variety of environments including open field, field-forest edge, open woods, and roadside.

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

Part 1: Nest Predation Data

Nest predation rates on artificial nests were tested with a field experiment using quail eggs from Lake Cumberland Gamebird Farm (Fig. 1). Each autumn olive plant was paired with a native species of similar structure occurring at least 1 meter and no more than 20 meters away from each autumn olive.

Eleven nest pairs were placed within plants (at heights varying from 30 cm to 1.5 m) on June 23, 2008 and left until July 7, 2008 (14 days). These above-ground nests were made in the following manner: a square of chicken wire was threaded with grasses from within PCCI property, then molded into a nest shape about 12 cm diameter. They were attached to the branches using floral wire, and 5 eggs were placed in each nest. They were checked both morning and evening for nest predation.

Fourteen nest pairs were placed on the ground (touching the base stems) of autumn olive plants and paired natives in a different area from July 14, 2008 to July 27, 2008, at a time when nest predation rates are known to be high in the Midwest (Heys and Keys 2006). These ground nests were made by plucking nearby grasses and placing them in a pile near the base of the plant,

and 5 eggs were placed in each nest. They were checked once each day for 14 days for nest predation. In order to ensure that a human scent trail did not affect the results, Wildlife Research Center Scent Killer was used on the nests, and on gloves, boots and pants worn when checking the nests.

The types of predators expected were primarily small mammals such as red squirrels (*Tamiasciurus vulgaris*) and large birds such as blue jays (*Cyanocitta cristata*). Since the quail eggs were not warm, reptilian predators were not likely.

Figure 1. Map of Nest Predation Sites at PCCI.
(blue=raised nest sites, yellow=ground nest sites)

Part 2: Natural Nest Census

A natural nest census was conducted late in the summer (to allow time for a maximum number of nests) in order to discern preferences of ground and tree-nesting birds. On August 6-7, 2008, 20 focal autumn olive and 20 focal native shrubs (≤ 6 m in taller trees) were searched for all bird nests.

Part 3: Arthropod Availability

The impact of relative arthropod food abundance and food type in autumn olive was evaluated in three different ways: arthropod netting, flypaper traps, and branch beating (Fig. 2).

Arthropod netting was focused toward flying insects and overall insect mass. A 0.3048 m diameter butterfly net was used to capture insects. Each autumn olive plant was paired with a native tree or another shrub that was at least one meter and no more than 10 meters away. The net was then swept 20 times past the lower branch tips of each plant. The insects netted were put into sealable plastic bags and put into a freezer. After at least 3 hours (but no more than 24

hours), the insects were counted and measured for biomass. A total of 32 pairs were sampled in all different pairs of shrubs, 16 on July 8-9, 2008 and 16 on July 29-30, 2008.

Flypaper traps were set in order to determine relative abundance of flying insects in autumn olive. The traps were made with plastic-coated hangers stretched into a diamond shape, and flypaper rolls coated with Tanglefoot (an unscented sticky substance) were unwound and stretched across the hangers. The traps were placed in pairs of autumn olive and a lower portion of a native tree or another shrub that was at least one meter and no more than 20 meters away. The traps were left for around 48 hours and counted in the field for number of insects and number of insects larger than 5 centimeters. A total of 20 pairs of traps were set, all in different shrubs, 10 on July 20, 2008 and 10 on August 8, 2008.

Branch beating was utilized in order to assess non-flying arthropods, especially caterpillars, in autumn olive versus native plants. Each autumn olive plant was paired with a native tree or another shrub that was at least one meter and no more than 10 meters away. A white sheet was draped under a main branch of the plant; using the pole of a butterfly net, the plant was hit 30 times in order to shake off all arthropods. The number of arthropods and the number of caterpillars collected was recorded. A total of 45 pairs were sampled, all on different pairs of shrubs, 15 on July 7, 2008, 15 on July 23, 2008, and 15 on August 11, 2008.

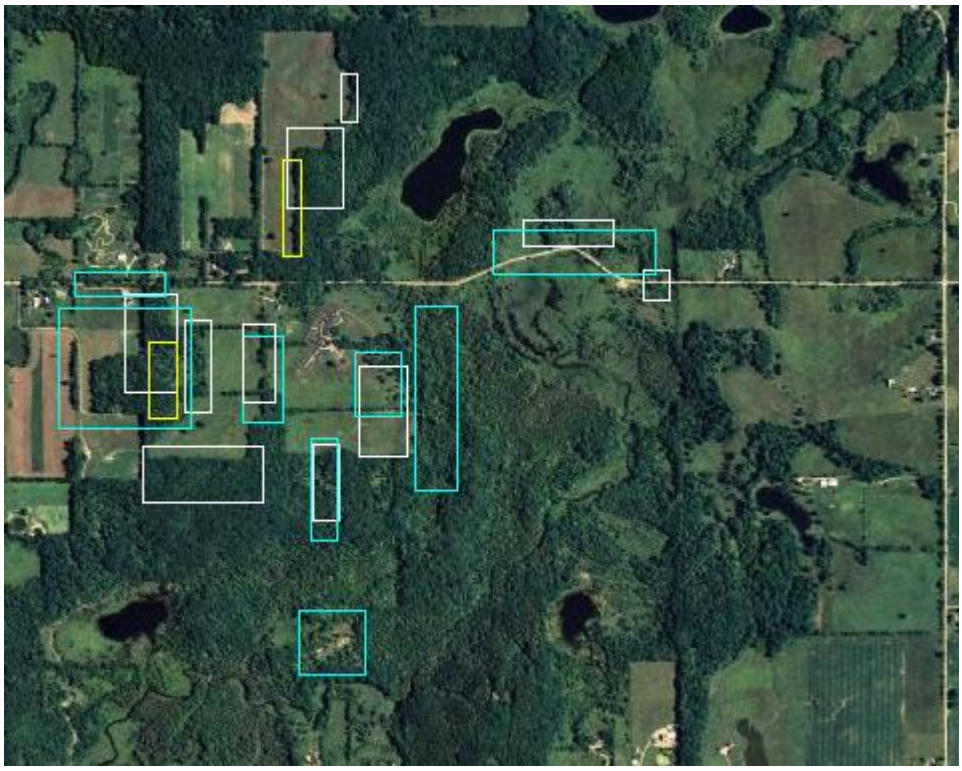

Figure 2. Map of Arthropod Availability Study Sites at PCCI
(white=insect netting, yellow=flypaper traps, blue=branch beating)

Part 4: Bird Activity Census

Activity of breeding birds in areas of high autumn olive density were compared to areas of no autumn olive in order to measure how birds may prefer autumn olive in their environment. This set of data was collected using point-counts along transect lines, with each point along a transect matching another (Fig. 3). Transect lines were walked from sunrise (approximately

0600) to approximately 0745 from July 9, 2008 to August 1, 2008. A total of 16 paired points were assessed. Point counts were conducted in the following manner: each point was determined by a random number of steps into the appropriate area (high autumn olive density or free of autumn olive). Three minutes passed before counting, and counting continued for 15 minutes afterward. All birds heard and seen in the area (excepting birds flying overhead) were counted; both bird diversity and number were recorded. Data were collected on each transect at least two different mornings to ensure that all birds present were counted.

Bird activity was also measured in individual autumn olive plants to determine cover and roosting preferences. Focal Autumn Olive shrubs were paired with a close native of similar size. These pairs were observed for one hour between the hours of 0900-1100 and 1600-2000. A total of 30 A.O./native pairs were observed between July 19, 2008 and August 16, 2008; total number of individuals and total number of species were recorded.

Figure 3. Map of Early-Morning Point Count Areas at PCCI

Results

Part 1: Nest Predation Data

Raised nests received a total of 90% predation. The mean number of days without predation was 6.1 days (±3.5 s.d.) in Autumn Olive nests and 5.4 days (±3.8 s.d.) in native nests. There was no significant difference between Autumn Olive nests and native nests in both amount of time before nests were discovered and in the rate of predation (sign tests, N=10, b=6, p=0.377; N=10, b=6, p=0.377).

Ground nests received a total of 50% predation. The mean number of days without predation was 11 days (±5.0) in Autumn Olive nests and 12.6 days (±2.6) in native nests, though

these data are skewed because a large portion of nests never received predation during the 14-day period. There was no significant difference between Autumn Olive nests and native nests in both of the above categories as well (sign tests, N=7, b=4, p=0.50; N=7, b=4, p=.50).

It is interesting to note that two different types of predation events appeared to be occurring in the two different nesting categories (See Tables 1 and 2). The raised nests appeared to be preyed upon by a bird because of the peck markings left on quail eggshells; the eggs were also taken over a longer time-span (a period of 2-3 days rather than all at once). The ground nests, however, appeared to be preyed upon by a small mammal because the quail eggshells were crushed (rather than picked apart) and the eggs, if found, would be taken all at once.

Table 1. Raised Nest Predation
(Numbers of eggs left in nest; first number is morning, second is evening)

DAY		1		2		3		4		5		6		7		8		9		10		11		12		13		14	
Pair 1	**AO**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 2	**AO**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	2	2	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 3	**AO**	5	5	5	5	5	5	5	5	5	5	5	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2	2	0	0	0	0	0	0	0	0	0	0	0
Pair 4	**AO**	5	5	5	5	5	5	5	5	5	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	4	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 5	**AO**	5	5	5	5	5	5	5	5	5	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	3	3	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 6	**AO**	5	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 7	**AO**	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pair 8	**AO**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	3	3	3	3	3	3	3	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3	3	3	3	2	2	2	2	2	0	0	0	0
Pair 9	**AO**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 10	**AO**	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4
	NA	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Pair 11	**AO**	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	2	2	2
	NA	5	5	5	5	5	5	5	5	5	5	5	5	4	4	3	3	3	2	2	2	2	2	2	2	2	2	2	2

Table 2. Ground Nest Predation
(Number of eggs left in nest)

DAY		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Pair 1	AO	5	5	5	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	0	0
Pair 2	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	0	0	0	0	0
Pair 3	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	0	0	0
Pair 4	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 5	AO	5	0	0	0	0	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 6	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 7	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 8	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 9	AO	5	5	5	5	5	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 10	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 11	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 12	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	0	0	0	0	0	0	0	0	0
Pair 13	AO	5	5	5	5	5	5	5	5	5	5	5	5	5	5
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Pair 14	AO	5	5	5	5	5	0	0	0	0	0	0	0	0	0
	NA	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Part 2: Natural Nest Census

The natural nest census yielded no visible nests in any of the 40 shrubs, Autumn Olive or native. However, the ground below 9 of the 20 Autumn Olive shrubs was disturbed, indicating the presence of a mammal, as compared to 1 of the 20 native shrubs.

Part 3: Arthropod Availability

Three rounds of insect netting resulted in a mean of 10.7 (±6.9) insects caught in Autumn Olive and 10.4 (±9.9) insects caught in natives, as well as a mean of 0.07g (±0.086) wet biomass from Autumn Olive netting and 0.04g (±0.037) wet biomass from native shrub netting. This method revealed no significant differences between Autumn Olive and natives either in total number of insects or total biomass (sign tests, N=30, b=17, p=>0.05; N=31, b=17, p=>0.05).

Two sets of flypaper traps resulted in a mean number of 140.8 (±28.4) insects caught in Autumn Olive and 130.2 (±41.5) insects caught in natives in July, and a mean number of 35.7 (±9.9) insects caught in Autumn Olive and 24.4 (±6.9) insects caught in natives in August. The mean number of large insects was 4.85 (±4.04) in Autumn Olive and 3.95 (±4.83) in natives. While July flypaper traps revealed no differences in either total number of insects or number of

large insects, August flypaper traps (Fig. 4) showed more insects in Autumn Olive than in native shrubs (Wicoxon signed-rank test, N=10, T=3, T(crit)=8, p>0.05), and overall (Wilcoxon signed-rank test, N=20, T=21, T(crit)=59, p>0.05).

Three samples of branch beating resulted in a mean of 5.5 (±2.4) arthropods in Autumn Olive and 5.7 (±2.1) arthropods in natives, as well as a mean of 0.55 (±1.19) total caterpillars on Autumn Olive and 1.8 (±1.68) on natives. These data showed no significant differences (sign tests, N=39, b=25, p>0.05; N=31, b=28, p>0.05).

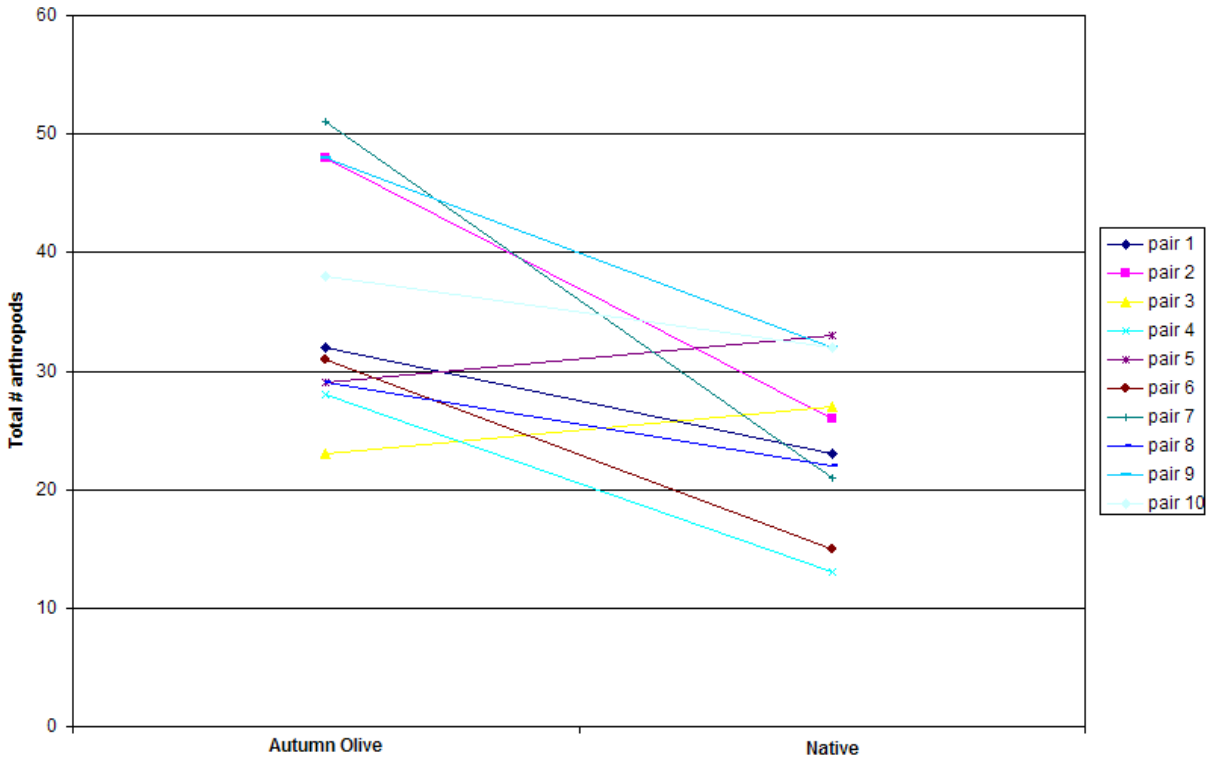

Figure 4. August Flypaper Trap Collection: Number of Arthropods Across Paired Shrubs

Part 4: Bird Activity Census

Early-morning point counts revealed no differences in number or diversity of birds in either areas of high Autumn Olive density or no Autumn Olive (Table 3).

TABLE 3. EARLY MORNING POINT COUNTS

	NUMBER OF SPECIES		NUMBER OF INDIVIDUALS	
TRAIL	**AVG IN AO**	**AVG IN NATIVE**	**AVG IN AO**	**AVG IN NATIVE**
RED PT 1	5.5	6	7.8	6.8
RED PT2	5.5	6.8	6.3	7.5
YLW PT 1	7.6	5.3	9.3	7
YLW PT 2	5.3	5	6.3	7.6
FLD PT 1	6	5.5	7	8
FLD PT 2	8.5	4	10.5	4.5
ORG PT 1	4.5	5	4.5	6.5
ORG PT 2	5	5.5	7	7.5

Daytime point pairs showed a mean of 1.1 (±1.5) birds in Autumn Olive 2.8 (±2.15) birds in natives. This method revealed that birds significantly preferred native shrubs over Autumn Olive (Sign test, N=15, b=15) (Fig. 5). Table 4 reports all species seen and heard from the daytime point pairs in their respective shrubs.

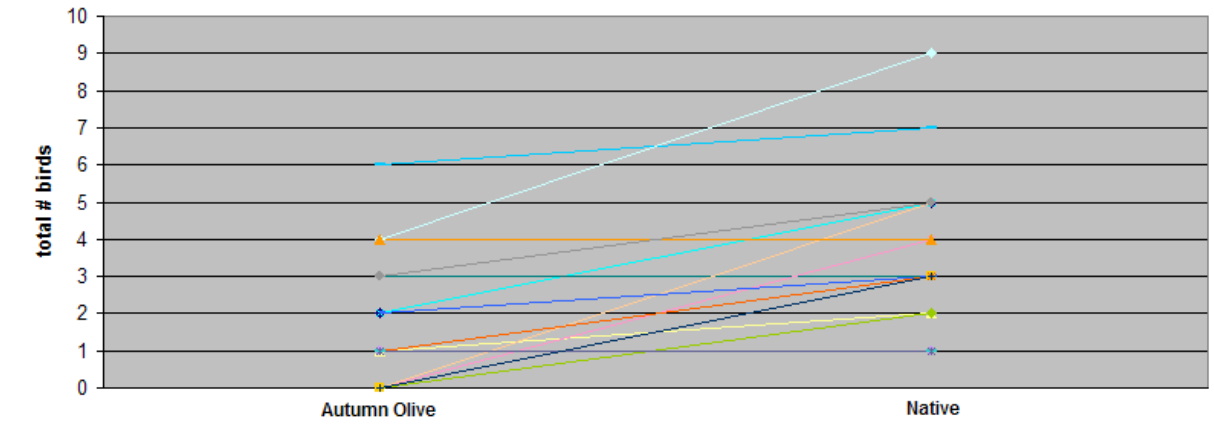

Figure 5. Daytime Point Pairs: Numbers of Birds in Autumn Olive vs. Native Shrub

TABLE 4. DAYTIME ACTIVITY CENSUS: SPECIES OF BIRDS SEEN IN SHRUB PAIRS

AUTUMN OLIVE	NATIVES
American Robin (*Turdus migratorius*)	American Robin (*Turdus migratorius*)
Black-capped Chickadee (*Parus atricapillus*)	Black-capped Chickadee (*Parus atricapillus*)
Grey Catbird (*Mimus polyglottos*)	*Blue Jay (*Cyanocitta cristata*)
Field Sparrow (*Spizella pusilla*)	Grey Catbird (*Mimus polyglottos*)
House Wren (*Troglodytes aedon*)	*Cedar Waxwing (*Bombycilla cedrorum*)
Rufous-sided Towhee (*Piplio erythrophthalmus*)	*Chipping Sparrow (*Spizella passerina*)
Tufted Titmouse (*Baeolophus bicolor*)	*Downy Woodpecker (*Picoides pubescens*)
White-breasted Nuthatch (*Sitta carolinensis*)	American Goldfinch (*Carduelis tristis*)
Common Yellowthroat (*Geothlypis trichas*)	House Wren (*Troglodytes aedon*)
	Indigo Bunting (*Passerina cyanea*)
	Mourning Dove (*Zenaida macroura*)
	Northern Cardinal (*Cardinalis cardinalis*)
	Rufous-sided Towhee (*Piplio erythrophthalmus*)
	* Eastern Wood-Pewee (*Contopus virens*)
	* Common Yellowthroat (*Geothylis trichas*)
	*Yellow Warbler (*Dendroica petechia*)

*=Feeds by sallying forth to catch insects

Discussion

Part 1: Nest Predation Data

Because the artificial nest predation experiment revealed no differences between Autumn Olive and natives in either raised nests or ground nests, it seems unlikely that Autumn Olive has an effect overall on the nest predation rates for birds at PCCI, although this was a small sample size, and this experiment was conducted in the summer rather than the spring, when other birds are nesting. The experiment was also conducted at a time when numbers of predators, especially raccoons, are missing from the area (Heys and Keys 2006), which could have affected the results.

The differences in predation events between raised nests and ground nests may result from the difference in experimental sites, the difference in times of the experiment, or from the type of nest itself (raised vs. ground).

This study utilized a wide array of habitat types, especially roadsides and trail sides, at which occurred a great number of predation events. Because predators may use deer trails and other avenues "to access the interior of a forest to prey upon bird nests" (Heys and Keys 2006), a study investigating the potential impacts of roads or trails on predation in Autumn Olive could be a topic for further study. This is especially interesting considering Autumn Olive commonly invades the disturbed habitats of roadsides and trail sides.

Part 2: Natural Nest Census

Because no nests were found during this census, it is possible late August was not an ideal time; the heightened amount of foliage in August makes the nests much harder to find. As a result, this author suggests a repeat of this experiment in the winter months or early spring, so that nests are more visible from a greater distance, and in order to survey a larger area for these apparently rare nests.

The results of a natural nest census is related to the nest predation results; if birds commonly prefer to nest in Autumn Olive, then no heightened probability of predation could mean that Autumn Olive is not only a good provider of fruit in autumn but also a beneficial nesting site.

Part 3: Arthropod Availability

Because the flypaper traps appeared to show Autumn Olive offering a heightened number of flying insects than native plants, this could mean that Autumn Olive is superior in insect availability in the non-fruiting season, especially in August. This would be especially more attractive to birds of the "sally forth" guild, rather than birds who will glean from branches (who focus on crawling arthropods). Since Autumn Olive appeared to offer no better arthropod availability to the gleaning birds, Autumn Olive may be more beneficial to some birds than others. However, the insect netting method did not support the conclusion made by the flypaper trap method, so the issue of heightened insect availability is still in question.

Part 4: Bird Activity Census

Because a greater number of birds were seen in they daytime in natives than Autumn Olive, birds may prefer native shrubs for any number of factors, which may include cover or food. A look at the specific reasons why birds may prefer natives would be a useful topic for further study.

Especially questionable is why a number of birds belonging to the "sally forth" guild were found in natives shrubs, when Autumn Olive appeared to offer more flying insects than natives in the arthropod availability study.

General Conclusions

In the non-fruiting season, Autumn Olive appears to neither receive greater predation rates nor offer any less arthropod availability than native plants (if anything, it offer more), yet birds prefer natives over Autumn Olive. The picture of the bird-plant interaction here is clearly incomplete, and many further studies will be needed in order to define exactly how beneficial or detrimental Autumn Olive may be to the bird community.

The most interesting conclusion from this study is that while Autumn Olive may offer more flying insects, those birds that feed on these insects prefer natives. This shows that there are still unknown factors influencing birds in the choice between Autumn Olive and native shrubs.

While this study focused on comparing Autumn Olive with its native neighbors, Autumn Olive is quickly becoming a problem in the open forest understory, filling in where no shrubs yet grew. The effects of this new "Autumn Olive understory" on birds and on the forest ecosystem have yet to be defined, and could be the next area of intensive Autumn Olive study in order to execute appropriate management of the invasive species.

Acknowledgements

The author wishes to thank the staff of Pierce Cedar Creek Institute for funding this study, as well as the other researchers at PCCI during the summer of 2008 and their faculty advisors, especially Dr. David Dornbos for his Autumn Olive expertise and Rachel Hesselink, who graciously worked around me in her Autumn Olive research.

Literature Cited

Catling, P.M. 2005. Effects of invasive alien plants on birds: some examples from North America. Biodiversity 6(3): 30-39.

DeGraaf, R.M. 2002. Trees, Shrubs, and Vines for Attracting Birds. Univ. Press of New England, NH: 87-88.

Finch, D.M. and S.H. Stoleson. 2001. Breeding bird use of and nesting success in exotic Russian Olive in New Mexico. Wilson Bulletin 113(4): 452-455.

Gazda, R.J., R.R. Meidinger, I.J. Ball, and J.W. Connelly. 2002. Relationships between Russian Olive and duck nest success in Southeastern Idaho. Wildlife Society Bulletin 30(2): 337-344.

Heys, B. and R. Keys. 2006. The potential habitat fragmentation caused by white-tailed deer (*Odocoileus virginianus*) and its impact on nest predation. Available from <http://www.cedarcreekinstitute.org/research-findings.htm>. 23 Jan 2008.

Travis, J. and J. Wilterding. 2005. Assessment of autumn olive (*Elaeagnus umbellata*) population at Pierce Cedar Creek. Available from <http://www.cedarcreek institute.org/research-findings.htm>. 23 Jan 2008.