

ASSESSING THE RELATIONSHIP BETWEEN INVASIVE BERRY PRODUCING PLANTS AND BIRD COMMUNITIES IN WETLANDS

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ABSTRACT

Invasive plants have been shown to have a profound effect on their ecosystem. Wetland ecosystems are easily impacted by these invasive plants which then may shape the wildlife community in the wetland. Research was conducted at four constructed wetland sites of similar composition, in Central Pennsylvania, to determine whether there is a relationship between the density of invasive berry producing plants and bird communities in wetland environments. Berry scores, based on abundance and density, were calculated to rank each of the four wetlands from least to greatest availability of invasive berry producing plants. We found no significant correlation between frugivorous bird density and invasive berry density ($r = -0.322$, $p = 0.678$). Conservation scores were assigned to each species. We found no significant correlation between the density of frugivorous birds of conservation concern and berry density ($r = -0.453$, $p = 0.547$). An analysis of species richness for birds by site also produced statistically insignificant results ($r = 0.239$, $p = 0.761$). Analysis of migratory vs. residential species richness ($r = 0.742$, $p = 0.258$) and proportion ($r = 0.829$, $p = 0.171$) compared to invasive berry density also exhibited little to no significant correlation. We also compared the density ($r = -0.114$, $p = 0.886$) and species richness ($r = 0.895$, $p = 0.105$) of insectivorous birds to the density of invasive berry producing plants and found no significant correlation. Overall, the study was unable to confirm that there is a relationship between the density of invasive berry producing plants and the density of frugivorous bird species in wetland environments.

Key words: Birds, wetlands, invasive berries, avian community structure, species density

INTRODUCTION

Many bird species use wetland sites due to the abundance of resources (Stewart, 2016). Food availability in wetland habitats supports a wide distribution of different bird species with varying dietary restrictions and many bird species find wetlands especially attractive due to the abundance of herbaceous plants (Weller, 1999). Some birds use wetlands exclusively. 138 of the roughly 1900 North American bird species are wetland dependent (Stewart, 2016). Wetlands provide key habitat with necessary resources, meeting a multitude of needs for bird species. The unique environment allows birds to stay in a small area, protected from predators and weather (Stewart, 2016).

Arguably one of the most important habitats types to conserve presently is wetlands. Wetlands have a history of being destroyed and reclaimed for

mankind's own use, causing wetlands to become some of the most degraded habitats, resulting in habitat loss for many species (Amezaga et. al, 2002). Due to the loss of habitat and their importance as stopover, wetlands became the first major ecosystem to be protected by an international treaty. The treaty was known as the "Convention on Wetlands of International Importance Especially as Waterfowl Habitat" and it designated 1108 sites as wetlands of international importance for migrating birds (Amezaga et. al, 2002).

With wetlands in many areas being protected and new wetlands being created, wetland habitats are slowly coming back to the landscape in the United States. However, there are still many threats to wetland habitat. Rich soils, ample water, abundant nutrients, and extensive canopy gaps, cause wetlands to be especially vulnerable to invasive species (Kercher 2010). When invasive species take over a

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wetland they alter the habitat, outcompeting native species that would normally be prevalent, forming monotypes, ultimately lowering the overall biodiversity of the wetlands (Kercher 2010).

During the autumn months, berries and fleshy fruits become an important food source for birds as the availability and presence of insect decline (Baird, 1980). Birds that consume berries are attracted to wetlands by the many different berry producing plants that thrive in these environments such as Pokeweed (*Phytolacca americana*), Greenbrier (*Smilax rotundifolia*), Autumn olive (*Elaeagnus umbellata*), Multiflora rose (*Rosa multiflora*), Barberry (*Berberis thunbergii*), and Honeysuckle (*Lonicera*). However, many of these plants are invasive and reproduce with very little competition (Weller, 1999). Wetlands are especially susceptible to the spread of invasive plants and while studies have shown the availability berries increases the abundance of frugivorous bird species, less is known whether birds have a food preference with respect to invasive berries, or if berries from invasive plants result in increased bird density or species richness in wetlands (Stewart 2016).

While berries are an important food source in late fall, insects are still prevalent and important food sources during early fall migrations. Invasive plants have also been shown to impact the abundance and diversity of invertebrate populations in ecosystems as studies show that insects prefer native plants over invasive plants (Herrera and Dudley, 2003). This suggests that wetlands with higher invasive densities are likely to have less insects and support a lower diversity of insectivorous bird species. The goal of this study was to determine if there is a relationship between bird communities and the abundance of invasive berry producing plants in wetland habitats.

STUDY AREA

Four wetland sites in Huntingdon and Blair Counties, Central Pennsylvania, were studied during a six-week period in the fall of 2017. All Selected wetlands had similar habitat composition and varied in the amount of invasive berries present. Selected sites included: Old Crow Wetlands, the beaver ponds at Canoe Creek State Park, as well as Brumbaugh and Fouse's Crossings. All four of the selected wetland sites support a similar composition of herbaceous plants such as emergent cattails, grasses and sedges, as well as a variety of fruit bearing plant species. Each of the wetland sites also shared roughly the same amount of water cover and habitat type. Each of the wetlands exhibited varying amounts of invasive berry producing plant cover.

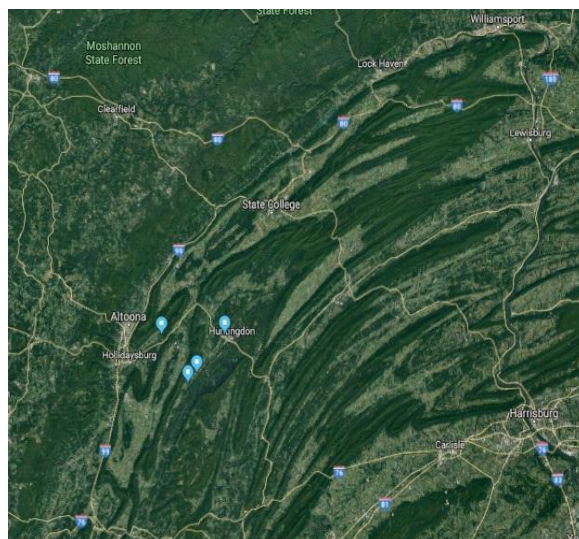


Figure 1. Location of four wetland sites in Huntingdon and Blair Counties, in Central Pennsylvania.



Old Crow Wetlands



Canoe Creek



Brumbaugh Crossing



Fouse's Crossing

Figure 2. Aerial photos of Four wetland sites, in Central Pennsylvania. Two transect lines in each wetland (marked in yellow) of 200 – 300m were used in this study during the fall of 2017.

Research conducted in the spring of 2018, studying the foraging behavior of insectivorous birds in the presence and absence of high invasive berry density at 2 of the wetlands that had been studied during the fall research period: Old Crow Wetlands and Brumbaugh Crossing.

METHODS

In each of the four wetlands, we established two lines of transects of 200 – 300 meters each, in which to determine invasive berry density as well as the density of frugivorous birds through visual and audible identification within 30 meters of the transect line (Figure 2). Each transect ran adjacent to the wetland area.

We quantified invasive berry abundance for each invasive berry producing plants identified using invasive berry density score cards on a scale of one to five, one representing little to no berries, and five representing a full load of berries (Figure 3). Each invasive berry producing plant observed was given a score based on the designated categories. The scores were then summed to produce an overall invasive

berry score for each site. Each site was then categorized based on its overall invasive berry score. We calculated invasive berry scores for each of the four sites at the start of our 6-week research period and again at the close of our research period.

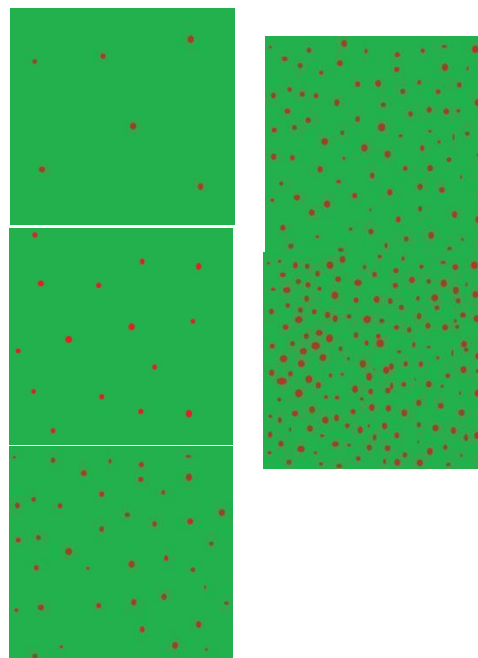


Figure 3. Example berry score system, ranking 1 – 5, in correspondence to the number of berries on each plant



Figure 4. Identifying invasive berry producing plant species and determining berry scores at research sites at the beginning of the research period, September 2017.

We surveyed each of the four wetland sites once every week for six weeks between the hours of 6 AM and 10 AM. Twenty - thirty minutes were spent identifying bird species seen or heard within 30 meters

of the two transect lines at each of the four sites (Figure 2). Birds observed outside of the designated transect area and outside of the time frame were not counted in the study. Only frugivorous birds, whose diet included berries and fleshy fruits, were counted in the survey. Surveys were not conducted on days exhibiting heavy rains and high winds, or days where weather limited bird activity. We assessed wind speeds using the Beaufort Wind Scale and weather was checked each day before going into the field.

We calculated the area of each of our transects into hectares and compared the area to the number of berry eating birds observed, species richness, and berry scores of each individual site to determine density. We used a Pearson's Correlation method to compare invasive berry densities to frugivorous bird densities and species richness densities (minitab, version 18).



Figure 5. Identifying bird species at Old Crow Wetlands during the fall of 2017.

Further field research was conducted in the spring of 2018 at Old Crow Wetland and Brumbaugh Crossing. The goal of the spring research design was to determine the relationship between insectivorous birds and invasive berry producing plants in wetlands. We hypothesize that an increase in invasive plants would result in a decrease in insect abundance, and therefore a decrease in insectivorous bird species should be exhibited.

A feeding tray of meal worms was placed at each of the two wetland sites (Old Crow Wetlands and Brumbaugh Crossing) to record avian feeding events. Observers were positioned in blinds to observe feeding events for 1 hour at each of the two wetland sites between the hours of 5 pm and 8 pm, once a week for three weeks.



Figure x. Eastern Phoebe with mealworm at Old Crow Wetland, spring 2018.

During the spring of 2018, we also analyzed all our data from the six-week study period during the fall of 2017 to compare the density and species richness of migrant and resident bird species to the density of invasive plants at each of the four wetlands. Insectivorous bird density was also compared to invasive berry density at each of the four wetland sites. A Pearson's Correlation method was used for statistical analysis of the data compared. (minitab, version 18).



Figure x. Eastern Phoebe and feeding tray of mealworms at Old Crow Wetlands, spring 2018.

RESULTS

During our research, we observed a total of 1,588 birds that make up 63 different species. Of the 1,588 birds observed, 889 individuals in 29 species,

were frugivorous bird species. A wide variety of invasive berry producing plants were also identified at each of the four wetland sites. Although, no birds were actually observed consuming berries during our research period, we know that the berries were being eaten by the reduction of berry abundance and density between the start and conclusion of our research. Site ranking, based on berry score for each of the four wetland sites, did not change from the start of our research to the end.

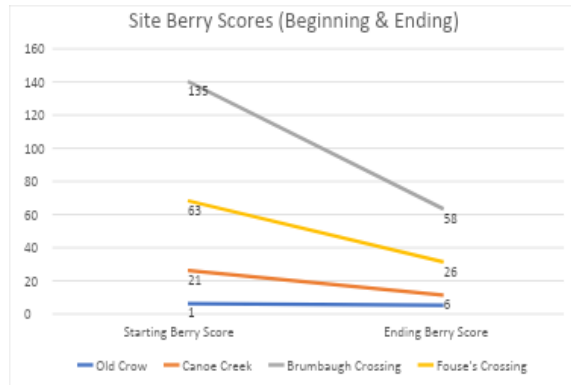


Figure 6. Invasive berry scores at four wetland sites in Central Pennsylvania were calculated in Fall of 2017 on the last week of September and the first week in November

Invasive berry score density did not affect the ranking of the four wetland sites (Table 1).

Table 1. Average Invasive Berry Score Per Hectare for Four Wetland Sites in Central PA, Fall 2017.

	AVERAGE BERRY SCORE	ARE A (HA)	INVASIVE BERRY DENSITY
OLD CROW	0.5	2.76	0.181
CANOE CREEK	13.5	3.06	4.41
FOUSE'S CROSSING	44.5	3.33	13.4
BRUMBAUG H CROSSING	96.5	2.88	33.5

The total number of frugivorous birds recorded during our research as compared to the area of each of the four wetland sites shows the density of frugivorous birds per hectare (Table 2, Figure 7.)

Table 2. Frugivorous Bird Density Per Hectare for Four Wetland Sites in Central Pennsylvania, Fall 2017.

The density of frugivorous bird species and the density of invasive berry producing plants were not significantly correlated. ($r = -0.322$, $p = 0.678$)

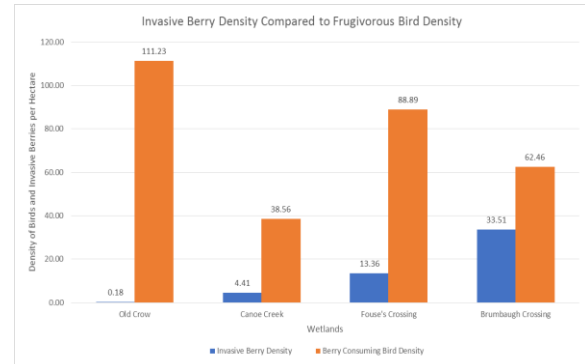


Figure 7. Comparison of invasive berry density and frugivorous bird density at four wetland sites in Central Pennsylvania during fall 2017.

The density of frugivorous birds of conservation concern and the density of invasive berry producing plants were not significantly correlated. ($r = -0.453$, $p = 0.547$)

Frugivorous Birds of Conservation Concern Compared to Invasive Berry Density

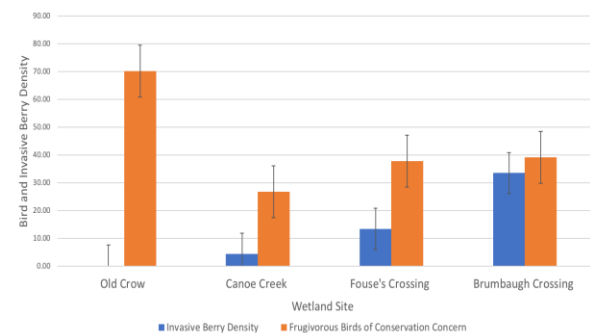


Figure 8. Frugivorous bird density compared to invasive berry density at four wetland sites in Central Pennsylvania during the fall of 2017, limited to birds of conservation score greater than 6.

Species Richness of frugivorous birds of conservation concern and invasive berry density was not significantly correlated. ($r = -0.071$, $p = 0.929$)

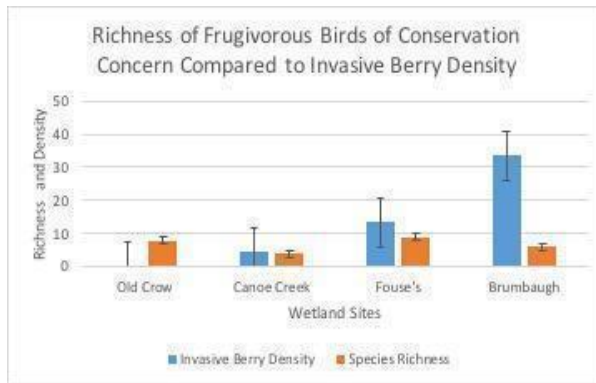


Figure 9. Species Richness of frugivorous birds compared to invasive berry density at four wetland sites in Central Pennsylvania during the fall of 2017, limited to birds of conservation score greater than 6.

Species richness and the density of invasive berry producing plants were not significantly correlated. ($r = 0.239$, $p = 0.761$)

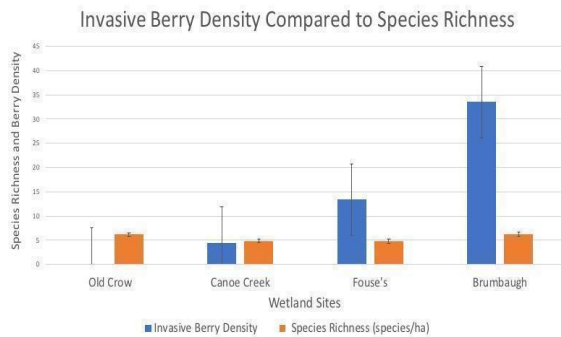


Figure 10. Comparison of invasive berry density and species richness at four wetland sites in Central Pennsylvania during the fall of 2017.

Species richness of migrants and residents was not significantly correlated to invasive berry density. ($r = 0.742$, $p = 0.258$)

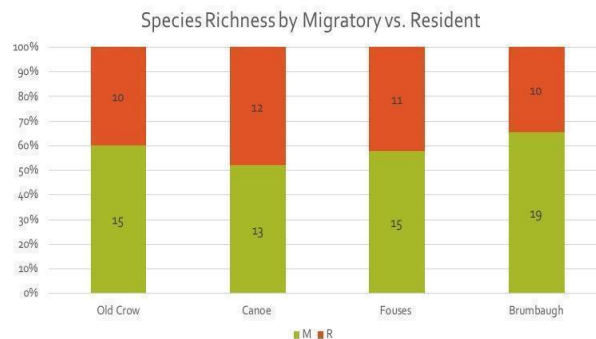


Figure 11. Migratory and resident species richness by invasive berry density at four wetlands in Central Pennsylvania during the fall of 2017.

Total number of individual migrants and residents were not significantly correlated to invasive berry density. ($r = 0.829$, $p = 0.171$)

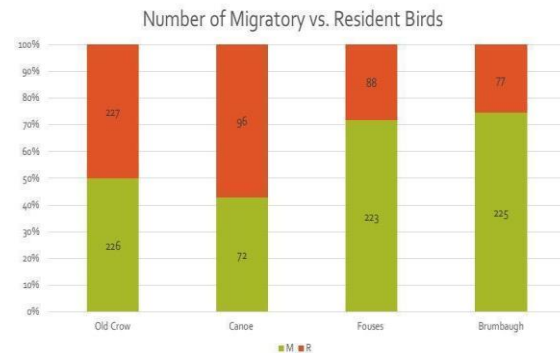


Figure 12. Total number of migratory and resident species by increasing invasive berry density at four wetlands in Central Pennsylvania during the fall of 2017.

Insectivorous bird density and invasive berry density was not significantly correlated. ($r = -0.114$, $p = 0.886$)

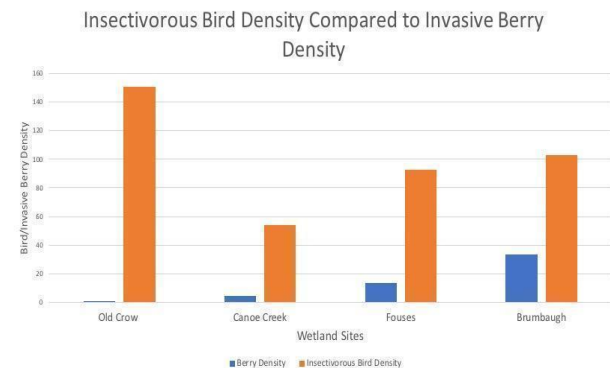


Figure 13. Insectivorous bird density compared to invasive berry density at four wetland sites in Central Pennsylvania during the fall of 2017.

Species richness of insectivorous birds and invasive berry density was not significantly correlated. ($r = 0.895$, $p = 0.105$)

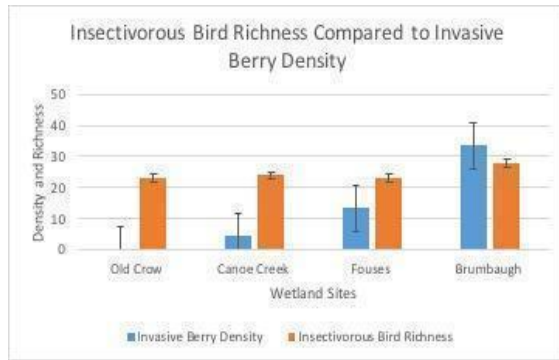


Figure 14. Species Richness of Insectivorous birds compared to invasive berry density at four wetland sites in Central Pennsylvania during the fall of 2017.

DISCUSSION

The goal of our study was to examine four wetland locations in Central Pennsylvania to determine whether invasive berry producing plants are driving the community structure of avian species in wetlands. Based on our results, we found little correlation between invasive berry densities and bird densities ($r=-0.322$, $p=0.678$). When we restricted data analysis to species of high conservation value ($r=-0.453$, $p=0.547$) and using species richness ($r=0.239$, $p=0.761$), there was still little to no correlation found. Analysis of migratory and residential species richness ($r=0.742$, $p=0.258$) and proportion ($r=0.829$, $p=0.171$) compared to invasive berry density also exhibited little to no significant correlation. We also compared the density ($r=-0.114$, $p=0.886$) and species richness ($r=0.895$, $p=0.105$) of insectivorous birds to the density of invasive berry producing plants and found no significant correlation. This indicates that invasive berry producing plants do not impact bird abundance.

This was the fourth year that this type of study has been conducted by Juniata College student researchers at the Raystown Field Station. Previous unpublished studies examined Old Crow Wetland, and Fouse's Crossing wetland, comparing berry production and bird species recorded. In one study conducted, student researchers Zachary Adams and Gordon Dimmig assessed the impacts of invasive berry producing plants on avian feeding guild structure. Adams and Dimmig found no significant difference in bird abundance between the two sites, nor did they find significant differences in density, richness, or species with high conservation values. This follows the same trend we observed in our own data, that there was no correlation in invasive berry producing plant density and bird density.

However, another unpublished study conducted by Juniata researchers in 2014 showed the opposite result. In 2014, there was a significant difference in abundance and richness, with Old Crow having higher abundances and richness than Fouse's Crossing. The differences in the results of 2014, 2015, 2016, and 2017 could be due to weather variations or other unforeseen variables. Once the data set continues to expand after multiple years of study, we may begin to see whether 2014 was an exception to the trend, or if invasive berries truly impact bird abundance.

Research conducted in the scientific community varies on the subject. Some studies have shown that birds do have a preference between choosing invasive berries and native berries (Lafleur et. al, 2006). Based on their studies, American Robins (*Turdus migratorius*) and European Starlings (*Sturnus vulgaris*) both preferred invasive berries over native in tests (Lafleur et. al, 2006). Their study would indicate that birds prefer invasive berries and we would expect to see higher bird densities in areas that have high densities of invasive berries. Other studies have also indicated that birds prefer invasive berries. One study recorded the visitations of birds at invasive plants versus native plants and counted the number of fruits consumed (Mokotjomela et. al 2012). Both of these studies contradict our study that showed no preference towards high density invasive berry sites. This also contradicts the previous 2014 study at Juniata College which indicated that there was a preference to sites with low invasive berry densities.

One study, conducted by Gleditsch and Carlo in 2011, suggest that some birds such as Gray Catbirds (*Dumetella carolinensis*) exhibit a preference for invasive berry producing plant species like honeysuckle (*Lonicera*), forming mutualistic relationships. Research shows that catbirds are often absent from locations having honeysuckle levels <100 fruits per plot (Gleditsch and Carlo, 2011). Arguments have been raised that the abundance of invasive plant species limits the amount of non-invasive and native plant species that are present in location. This hypothesis has been tested by placing potted black-nightshade plants (*Solanum nigrum*) in a location where honeysuckle was present in both high and low abundances to determine a preference between native and non-native berries. Upon conclusion of the study, 96% of the black-nightshade berries had been consumed in the location of high abundance of honeysuckle, while only 67% of the black-nightshade berries were consumed in location of low abundance of honeysuckle. (Davis, 2011) These studies suggest a preference for invasive berry producing plant species such as honeysuckle,

while many others including our own do not show this relationship.

We hypothesized that other avian feeding guilds, such as insectivores, may be impacted by high densities of invasive berry producing plants in wetlands. In 2003, Herrera and Dudley, studied the impacts of exotic invasive plants on the abundance and diversity of riparian arthropod abundances by sampling aerial, ground-dwelling, and other terrestrial arthropods in the presence and absence of *Arundo donax*, and aggressive invader of riparian habitat. Results of the study show a 50% decrease in aerial invertebrates, while ground-dwelling arthropods did not exhibit differences as great as that of aerial invertebrates (Herrera and Dudley, 2003). These results suggest that vegetation cover is a significant driver of invertebrate abundance and diversity. Due to the significant impact that invasive plants pose on insects, we would expect to see similar impacts to insectivorous birds. However, throughout our study we saw little correlation between insectivorous bird densities and invasive berry densities. It is possible that the invasive berry producing plants at our site do not act in the same way as *Arundo donax*. The previous study only compared the abundances of insects to one invasive plant while through the course of our study, the wetlands had been occupied by multiple invasive berry producing plants. Different invasive plants could have different impacts on insects and could possibly positively or negatively impact insect abundance or even have no effect on abundance at all.

In conclusion, research suggests that we should see higher bird densities at wetland sites with higher invasive berry densities. However, we have noticed no correlation between invasive berry densities and bird densities and prior research from these sites has indicated the exact opposite, that birds prefer lower densities of invasive berries. The differences in our results could be caused by various uncontrollable variables impacting bird selection of wetland sites. It has been suggested that various amounts of canopy cover could impact birds using wetlands (Petersen & Westmark 2013). Our wetland sites, as similar as they were, still had differences such as tree canopy cover. Other differences at our sites could be impacting bird densities and skewing data. More data from our sites should be collected in order to see if the trends recorded in our study continue and determine the cause.

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