# Bird Species Richness and Composition Relative to Different Forest Types at the Kitchel Lindquist Hartger Dunes Preserve

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**Introduction**

There are several factors that will impact bird species abundance and composition in a forest ecosystem. Generally speaking, forest structure plays a significant role in attracting certain bird species to a forest habitat (DeGraaf, Hestbeck, & Yamasaki, 1998; Diaz, 2006). The physical components of a forest, such as shrub composition, canopy age, height, and cover, as well as composition of conifers and hardwoods will all impact the vertical structure of a landscape (Diaz 2006). Furthermore, the habitat preferences vary significantly among different bird species and is therefore another important determinant of bird abundance and composition within a forest (DeGraaf, Hestbeck, & Yamasaki, 1998). When determining richness, abundance and composition of bird species within a forest ecosystem these factors and how they impact one another should be highly considered.

Pine plantations are not an unusual sight across the Eastern United States and are widely distributed in state of Michigan. It is often thought that pine plantations, especially those that are exotic, are less suitable than native habitats due to a decrease in vegetation composition and vertical structure which are important factors in wildlife colonization of a habitat (Lantschner, Rusch, & Peyrou, 2008). However, that is not necessarily the case. Many studies have found that pine plantations can be a suitable habitat if certain attributes are met. Plantations that are managed and periodically thinned tend to support more bird species as thinning allows for a greater shrub layer and increased coarse woody debris, thus creating greater habitat structure which is preferable to many bird species (Luck & Korodaj, 2008). Additionally, landscape

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diversity can help increase the wildlife value of a pine stand. A pine plantation that is nested within a mosaic of various forest types will offer greater access to resources and will actually be utilized more by various bird species compared to pine plantations that are in poor condition and isolated (Pino et al. 2000; Lantschner, Rusch, & Peyrou, 2008; Luck & Korodaj, 2008; Zamora et al. 2010; Gjerde, & Sætersdal, 1997).

The goal of this study was to determine if there was a significant difference between two different forest types in terms of vegetation structure and bird species richness and composition. This study highlighted the various bird species that would inhabit a forested back dune community and pine plantation within an open dune ecosystem. We wanted to determine the differences between each habitat type and to examine if one could be considered of higher habitat value than the other. Since the pine plantation is poorly managed and contains several exotic species we hypothesized that it would be considered a poor habitat when compared to the native dry-mesic forest adjacent to it (Gjerde, & Sætersdal, 1997). However, due to the pine plantations proximity to several other habitat types, we also thought it possible that this habitat type could be utilized more by birds than initially thought (Zamora et al. 2010). All together, we predicted that the dry-mesic forest would have a higher bird species richness, compostion, and abundance compared to the pine plantation forest.

**Methods**

*Study Area*

The study was conducted at the Kitchel Lindquist Hartger Dunes Preserve, a 46.5 ha dune ecosystem located along the eastern shore of Lake Michigan, north of the Grand River (figure 1.). The Dunes Preserve is a transitional landscape that demonstrates ecological succession from

open dunes to back dune forests. Six different plant communities can be found within the confines of this landscape and this area is host to an abundance of native flora and fauna (Martinus, 2005).

The study area focused on two distinct habitat types located at the preserve: a dry mesic-forest and a pine plantation. The dry-mesic forest is only found atop the largest forested dune at the site, known as Kitchel Dune. This forest is dominated by red oak and sassafras. The old growth forest slowly transitions into a mix of hardwood and conifers westward towards the open dunes. The pine plantation, also referred to as a pine forest, is located near the northern base of Kitchel Dune, and is a mix between red pine, scotch pine, and exotic pitch pine. Planted in the early 20th century, the pine forest contains little to no shrub layer and consists of a thick upper canopy. Human developments are highly concentrated directly west and southeast of the Preserve, however, a large portion of undeveloped forest resides directly north of the property.

*Landscape Characteristics*

In order to characterize the forest structure and stand characteristics of each habitat type, a 500m transect was established through each site. The starting point for the transect through pine plantation was N 43.06583º W 086.23981º and the transect ended at N 43.06549º W 086.24548º. For the transect along Kitchel Dune, the point started at N 43.06476º W 086.24091º and ended at N 43.06406º W 086.24368º.

Five nested 10m quadrats were established at random along this transect and were separated by at least 100m. Within each 10m quadrat, tree species and tree diameter at breast height (dbh) were recorded of all trees with a dbh greater than 5cm. Woody vegetation smaller than this measurement was considered a sapling. Structural characteristics such as snags and logs

were also recorded. Each quadrat was reduced to 5m x 5m area where saplings and shrubs were counted and recorded. Once again each quadrat was reduced to a 1m x 1m area where seedlings were counted and recorded.

*Bird Surveys*

Bird counts were conducted using 50m radius point counts along a 500m transect through each habitat type. Surveys were preformed during the summer of 2017 between sunrise and 10am. At each site, five point counts were randomly established along a 500m transect and were separated by at least 100m. At each plot, all birds within the 50m radius were counted along with all birds that flew through and directly over the plot. Each count lasted a total of 10 minutes with a two minute acclimation period before each count. Birds were identified either by sight or by sound.

*Statistical Analysis*

A species list of woody vegetation and bird species was complied for each habitat type. Using the data collected from the forest surveys, abundance, relative density, relative frequency, relative basal area, and importance index were calculated using Microsoft Excel Data Analysis ToolPak. Using the data collected from the point count surveys, species richness and relative abundance were calculated for each point count surveyed within each habitat. Additionally, these data were used to calculate the Shannon's Diversity index (H) (Shannon, 1948) for each habitat type and to determine the number of each species observed and the relative abundance of each species within the different forest types (Nur, Jones, & Geupel, 1999). Finally, a single factor

ANOVA (alpha = 0.05) was used to asses differences in bird species relative abundance and richness.

**Results and Discussion**

*Forest Metrics*

The two forest types that we sampled at the Dunes Preserve were distinctly different. As expected, the pine plantation had a lower species richness than the dry-mesic forests atop Kitchel Dune. Only three woody species were identified in the pine forest; red pine and pitch pine were the dominant species with the same relative density of 36.84. The less abundance scotch pine had a relative density of 26.32. Red pine was the most frequent species with a relative frequency of 41.67 but had the lowest relative basal area of 17.79 compared to scotch pine with a value of 44.27 indicating that the scotch pines sampled were large in size, even though they were less abundant. Overall, these metrics indicate that the pine plantation has a lower diversity than the dry-mesic forest on Kitchel Dune (Table 1.).

**Table 1**. Summary of forest metrics from two distinct forest types. Abundance is per 500m$^2$ per transect.

| Pine Forest | | | | |
|---|---|---|---|---|
| **Species** | **Abundance** | **Relative Density** | **Relative Frequency** | **Relative Basal Area** | **Importance Index** |
| *Scotch Pine* | 10 | 26.32 | 33.33 | 44.27 | 44.27 |
| *Pitch Pine* | 14 | 36.84 | 25 | 37.94 | 33.26 |
| *Red Pine* | 14 | 36.84 | 41.67 | 17.79 | 32.1 |

| Dry-Mesic Forest | | | | |
|---|---|---|---|---|
| **Species** | **Abundance** | **Relative Density** | **Relative Frequency** | **Relative Basal Area** | **Importance Index** |
| *Sassafras* | 24 | 45.28 | 26.67 | 37.48 | 36.48 |
| *Red Oak* | 10 | 18.87 | 20 | 50.93 | 29.93 |
| *Wild Black Cherry* | 11 | 20.75 | 26.67 | 6.31 | 17.91 |
| *Sugar Maple* | 2 | 3.77 | 13.33 | 0.35 | 5.82 |
| *Witch Hazel* | 5 | 9.43 | 6.67 | 0.65 | 5.59 |
| *Basswood* | 1 | 1.89 | 6.67 | 4.28 | 4.28 |

On the forested dune, sassafras was the most abundant species, with 24 individuals counted. Sassafras, along with red oak and wild black cherry had the highest relative density of 45.28, 18.87, and 20.75 respectively. Sassafras and wild black cherry were the most frequent species with the same relative frequency of 26.67. Red oak had the highest relative basal area at this site with a value of 50.93. The importance index for the species identified in the dry-mesic forest varied significantly from the pine forest, with greater diversity between the species at this site compared to the species found in the pine forest (Table 1.). Overall, the data show that the dry-mesic forests has a greater woody species diversity than the pine plantation with more differences between the relative metrics and a higher species richness.

*Bird Metrics*

Within each forest type, bird species were surveyed at five separate points. These surveys offered a snapshot into the different bird species that utilize each habitat type. In total, 18 bird species were identified between the two sites. There was an overlap of eight species between each site, which is not unexpected given the proximity of the sites to one another. In the pine forest, 12 species were found versus 13 in the dry mesic forest. The dry-mesic forest had a higher relative abundance of 0.72 compared to 0.67 in the pine plantation indicating that birds tended to use the forested dune more than the pine plantation (Table 2). These differences between richness and relative abundance where analyzed using a single-factor ANOVA. There was not a significant difference between these two values, but there were some interesting trends.

**Table 2**. Bird species richness, relative abundance, and diversity within five separate point counts within two distinct forest types.

| Quadrat Number | Pine Forest | | | | | | Dry-Mesic Forest | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Total | 1 | 2 | 3 | 4 | 5 | Total |
| *Richness* | 7 | 7 | 2 | 6 | 7 | 12 | 3 | 7 | 5 | 5 | 3 | 13 |
| *Relative Abundance* | 0.58 | 0.58 | 0.17 | 0.5 | 0.58 | 0.67 | 0.23 | 0.54 | 0.38 | 0.38 | 0.23 | 0.72 |
| *Diversity (H)* | | | | | | 1.9 | | | | | | 2.21 |

Furthermore, there was a greater diversity of bird species in the dry-mesic forest compared to the pine plantation, indicated by a higher H value of 2.21 in the dry-mesic forest compared to an H value of 1.90 in the pine plantation. There are several factors that will impact what bird species one may find if certain forest types (Table 2.). Habitat preference is one factor that plays an integral part in which habitat types birds will utilize (DeGraaf, Hestbeck, & Yamasaki, 1998; Diaz, 2006)) Additionally, DeGraaf, Hestbeck, and Yamasaki, (1998) determined that forest structure, rather than the cover-type and forest size-class, is one of the most important factors and indicators of which birds will inhabit certain forest types.

At each site, barn swallows and black-capped chickadees had the highest relative abundance; 32% and 26% in the pine plantation, and 22% and 27% in the dry-mesic forest respectively (Table 3.). Barn swallows were a very abundant species within the airspace above the property. The large flock nested in a nearby building which belonged to the private marina adjacent to the property. During point count surveys, flocks of barn swallows were observed flying directly over the forest habitats but were never observed actually utilizing the ground space. Chickadees on the other hand were frequently seen in both habitat types and were observed in four out of the five points along each separate transect. The differences in bird species composition between each site offers some insight into the variation of each habitat type.

**Table 3**. Bird species observed and relative abundance within two distinct forest types.

| Species | Pine Forest | | | |
| | Inside | FO/FT | Total Birds | RA % |
|---|---|---|---|---|
| *Barn Swallow* | 0 | 22 | 22 | 32 |
| *Black-capped Chickadee* | 17 | 1 | 18 | 26 |
| *Cedar Waxwing* | 4 | 6 | 10 | 15 |
| *American Robin* | 3 | 0 | 3 | 4 |
| *Chipping Sparrow* | 3 | 0 | 3 | 4 |
| *Northern Cardinal* | 2 | 1 | 3 | 4 |
| *Red-breasted Nuthatch* | 3 | 0 | 3 | 4 |
| *American Crow* | 1 | 1 | 2 | 3 |
| *Blue Jay* | 1 | 0 | 1 | 1 |
| *Common Grackle* | 0 | 1 | 1 | 1 |
| *Herring Gull* | 0 | 1 | 1 | 1 |
| *Song Sparrow* | 1 | 0 | 1 | 1 |
| *Total* | | | 68 | 100 |
| Species | Dry-Mesic Forest | | | |
| | Inside | FO/FT | Total Birds | RA % |
| *Black-capped Chickadee* | 12 | 0 | 12 | 27 |
| *Barn Swallow* | 0 | 10 | 10 | 22 |
| *Blue Jay* | 4 | 0 | 4 | 9 |
| *American Robin* | 3 | 0 | 3 | 7 |
| *Northern Cardinal* | 3 | 0 | 3 | 7 |
| *American Crow* | 0 | 2 | 2 | 4 |
| *Eastern Wood-pewee* | 2 | 0 | 2 | 4 |
| *Tufted Titmouse* | 2 | 0 | 2 | 4 |
| *Turkey Vulture* | 2 | 0 | 2 | 4 |
| *Vireo sp.* | 2 | 0 | 2 | 4 |
| *Red-breasted Nuthatch* | 1 | 0 | 1 | 2 |
| *House Sparrow* | 1 | 0 | 1 | 2 |
| *Northern Flicker* | 1 | 0 | 1 | 2 |
| *Total* | | | 45 | 100 |

*This table shows the number of each bird species counted inside the 50m point count radius, the number of birds that were observed outside the habitat either as flying over (FO) the point or flying through (FT) the point, the total numbers of each species observed and the relative abundance percentage (RA%) of each species.*

*Forest Variation and Bird Diversity*

Habitat type and vegetation structure play a crucial role in influencing the composition and richness of bird species in a landscape (DeGraaf, Hestbeck, & Yamasaki, 1998; Diaz, 2006). Additionally, composition of the understory or shrub layer will have a strong influence on which bird species colonize or utilize a habitat (Diaz, 2006; López, & Moro, 1997; Luck & Korodaj, 2008). Structurally, the dry-mesic forest had a greater understory than the pine plantation, which had a shrub layer of basically zero. The greater diversity in wood vegetation in the dry-mesic forest would also contribute to bird utilization. Overall, there were more trees observed on the forested dune than in the pine forest and these differences correlate with a higher bird species diversity in the dry-mesic forest.

Furthermore, habitat preference of the various bird species could also offer some insight to these differences. Eastern wood-pewees were one species that were only observed in the dry-mesic forest and are frequently found in deciduous woodlands during the summer (Cornell: Eastern Wood-pewee, 2015). The tufted titmouse is another species that is usually found in dense deciduous or mixed woodland (Cornell: Tufted Titmouse, 2015) and was only observed on Kitchel dune. Black-capped chickadees on the other hand were found in both habitats and are more of an opportunistic generalist species (Cornell: Black-capped Chickadee, 2015). The habitat preference of these species likely played a role in which habitats they utilized at the Dunes Preserve and is one attribute that should be taken into consideration when distinguishing the differences between these two forest types.

Overall, there were several differences between the two habitat types. The greater number of woody species and a more diverse forest structure correlates with the slightly higher bird species diversity, richness, and relative abundance in the dry-mesic forest and a slightly different

bird species composition between the two forests types. These values help support my hypothesis that the dry-mesic forest will have greater bird species richness, composition, and abundance compared to the pine plantation. However, these data do not mean that the pine plantation is a poor habitat for migrating bird species and permanent bird residents at the Dunes Preserve. Most likely, because of the proximity to several different habitat types such as open dunes and great lakes barrens, the pine plantation likely experiences greater use than an isolated habitat of the same structure and composition. This mosaic of habitat types allows for birds to utilize several communities at once and provides access to resources that some habitats may be lacking (Pino et al. 2000; Lantschner, Rusch, & Peyrou, 2008; Luck & Korodaj, 2008; Zamora et al. 2010; Gjerde, & Sætersdal, 1997). While the pine plantation is not the most suitable habitat within the surrounding area, it is still being utilized by many of the bird species that can be found at the Kitchel Lindquist Hartger Dunes Preserve most likely due to the mosaic of habitat types within this rich ecosystem.

## Appendix

*Species Lists*

| Birds | | |
|---|---|---|
| | **Number of Indiviudals** | |
| **Species** | **Pine Forest** | **Dry-Mesic** |
| *American Crow* | 2 | 2 |
| *American Robin* | 3 | 3 |
| *Barn Swallow* | 22 | 10 |
| *Black-capped Chickadee* | 18 | 12 |
| *Blue Jay* | 1 | 4 |
| *Cedar Waxwing* | 10 | 0 |
| *Chipping Sparrow* | 3 | 0 |
| *Common Grackle* | 1 | 0 |
| *Eastern Wood-pewee* | 0 | 2 |
| *Herring Gull* | 1 | 0 |
| *House Sparrow* | 0 | 1 |
| *Northern Cardinal* | 3 | 3 |
| *Northern Flicker* | 0 | 1 |
| *Red-breasted Nuthatch* | 3 | 1 |
| *Song Sparrow* | 1 | 0 |
| *Tufted Titmouse* | 0 | 2 |
| *Turkey Vulture* | 0 | 2 |
| *Vireo sp.* | 0 | 2 |
| *Total Individuals* | 68 | 45 |
| *Total Species* | 12 | 13 |
| *Shannon Index (H)* | 1.9 | 2.21 |

*List of bird species and the number of individuals found within each sampled forest type.*

| Woody Vegetation | | |
|---|---|---|
| | **Number of Individuals** | |
| **Species** | **Pine Forest** | **Dry-Mesic** |
| *Red Pine* | 14 | 0 |
| *Scotch Pine* | 10 | 0 |
| *Pitch Pine* | 14 | 0 |
| *Sugar Maple* | 0 | 2 |
| *Basswood* | 0 | 1 |
| *Sassafras* | 0 | 24 |
| *Red Oak* | 0 | 10 |
| *Wild Black Cherry* | 0 | 11 |
| *Witch Hazel* | 0 | 5 |
| *Total Individuals* | 38 | 53 |
| *Total Species* | 3 | 6 |

*List of woody species and the number of individuals found within each sampled forest type.*

*Map*



**Figure 1**. *Map of the Kitchel Lindquist Hartger Dunes Preserve, a 46.5 ha dune ecosystem, located in Grand Haven, Michigan, directly north of the Grand River channel. Two transects were established through the pine plantation and the dry-mesic forest on the largest forested dune (Kitchel Dune). Both transects run in a slightly southwest direction.*

*Photographs*



*Snapshot of the pine plantation. Notice the placement of the pines and the lack of a shrub layer. This portion was a mix of all three pine species.*
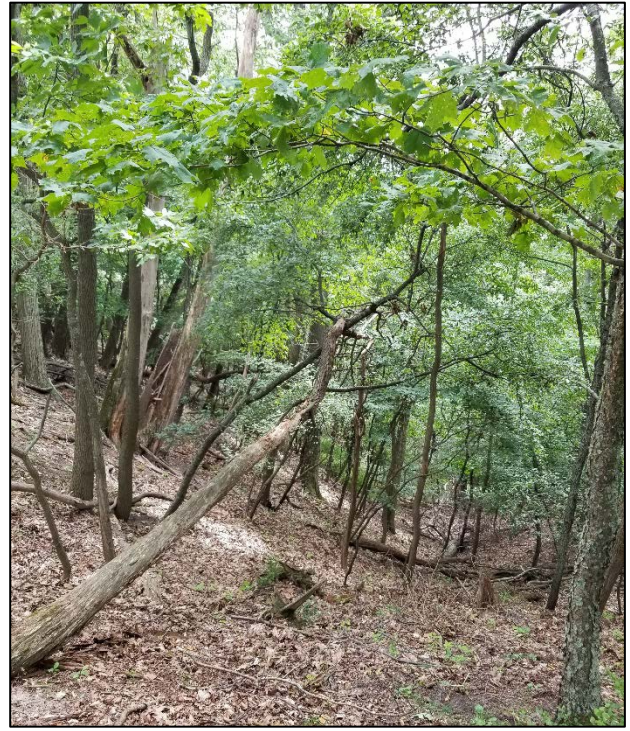




*Photos of the dry-mesic forest on Kitchel Dune. This forest grows along a backdune ridge and is dominated by hardwoods.*

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