American Kestrels are one of the smallest raptors in North America\(^{1}\). Weighing no more than a stick of butter (90-160 grams), this feisty predator will consume anything that moves, hops, or slither, making them valuable as pest control especially around agricultural fields. Unfortunately, despite their label as common species\(^2\), these birds face declining populations all across the US. Causes for this decline is unknown— there is speculation that this decline might be attributed to increases in predator population, pesticide use, and habitat loss.

To combat this, many conservation programs across the US are erecting artificial nest boxes to increase local kestrel populations. However, many of these do not get used. Some nest boxes remain abandoned, while others are used initially and then fall sharply in use in subsequent years. And while kestrel populations are generally in decline, there are some regions that experience increases in population. So are we guessing wrong on habitat? This study investigates on what actually constitutes good habitat for the American Kestrel and how a breeding pair chooses a nest site. The results from this study will help inform program managers where to place future nest boxes to help increase these charismatic raptor species.

**Results & Conclusions**

Based on the results, it is more beneficial to have nest boxes further away from dense human populations, closer to open habitat, further away from forest edge, and more surprisingly, closer to roads. The more suitable habitat at larger scales, the more likely you will run into competition with other kestrels. At the largest scale, these variables become favorable again, which may be indicative of a quadratic relationship with spatial scales instead of a linear one. For wetlands, it could be possible that these birds enjoy the amount of dragonflies and insects that hang around there.

**Non-Spatial Factors**

- **Distance to Roads**: 0.049
- **Distance to Forest**: 0.062
- **Distance to Wetlands**: -0.59
- **Distance to Transmission Lines**: 0.091
- **Nearest Occupied Nest Box**: -0.711

**Spatial Dependent Factors**

- **Total Population**: -1.73\(^*\)
- **Open Water**: -0.19
- **Woody Wetlands**: 0.19
- **Deciduous Forest**: -0.29
- **Mixed Forest**: 0.01
- **Shrub/Scrub**: 0.09
- **Emergent Wetlands**: -1.2
- **Urban Cover**: 2.18
- **Hay/Pasture**: 0.16
- **Grassland**: 0.04
- **Evergreen Forest**: 0.02
- **Habitat Perimeter: Area**: 0.72

**Other Variables**

- **Vector**: 0.19
- **Habitat Fragmentation**: 0.09
- **Distance to Transmission Lines**: 0.01
- **Habitat Fragmentation**: 0.09
- **Distance to Roads**: 0.049
- **Distance to Forest**: 0.062
- **Distance to Wetlands**: -0.59
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- **Nearest Occupied Nest Box**: -0.711

As part of a larger study, we will look into other state data and include a measure of openness using LiDAR to investigate variables that impact occupancy at a larger regional scale. We will also need to split roads into different types as highways may have different impacts than country roads.

**Habitat Fragmentation**

- **Habitat Fragmentation**: 0.09
- **Distance to Roads**: 0.049
- **Distance to Forest**: 0.062
- **Distance to Wetlands**: -0.59
- **Distance to Transmission Lines**: 0.091
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**Forest**

Forest cover consists of three types of forest—deciduous, evergreen, and mixed forest. We selected only forest cover from the NLCD data and vectorized the raster using ArcMap tool for raster to vector. We calculated the distance to nearest forest edge using the Near tool in ArcMap for each nest box.

**Transmission Lines**

Transmission lines are often used creating artificial open habitat for kestrels. We took transmission line data and selected for only above ground transmission lines. We calculated the nearest distance to above ground transmission lines using the Near tool in ArcMap.

**Wetlands**

Wetlands may provide open space and abundance of insects for kestrels to hunt. We included data from the US National Elevation Geospatial dataset and selected for only non-irrigated wetlands. We calculated distances to nearest wetlands using the Near tool in ArcMap.

**Methods**

Recent research has moved towards using a multi-scale approach, since animals, especially birds, may consider features in the landscape at coarser scales. For our study, we used several spatial scales to analyze nest site selection in American Kestrels. Since we don’t know at what level American Kestrels use to evaluate nest sites, we chose range of scales.

Using Arcmap ver. 10.5.1, we chose 3 major categories of scales and created 8 total circular buffers around the nest boxes (in meters radius):

1. **Nest Box Level**: (25, 50, 100, 400 m)
2. **Area around Nest Box**: (1000, 1250, 1500 m)
3. **Landscape Level**: (5000 m)

We then selected various different factors based on kestrel literature and observations from nest box managers (listed below) and imported data into tables for each nest box at each spatial scale. We used pairwise scatterplots and Pearson’s R to check for multicollinearity. For our study, we used nest box data from Madison Audubon, which consists of 153 total nest boxes placed around Madison, WI and over 7 years of occupancy data.

We created stepwise logistic regressions using the generalized linear model (GLM) in the statistical program, R ver. 3.5.1. This function adds on variables to each subsequent model and evaluates the best model using AIC (Akaike Information Criterion) scores. We used the best model with the variables that best explain for variance in occupancy and added year and individual nest box ID as random independent factors to account for possible pairs that may return to nest boxes in consecutive years. We split our results in nine total models, 8 with spatial dependent models for each scale and 1 for non-spatial scales.