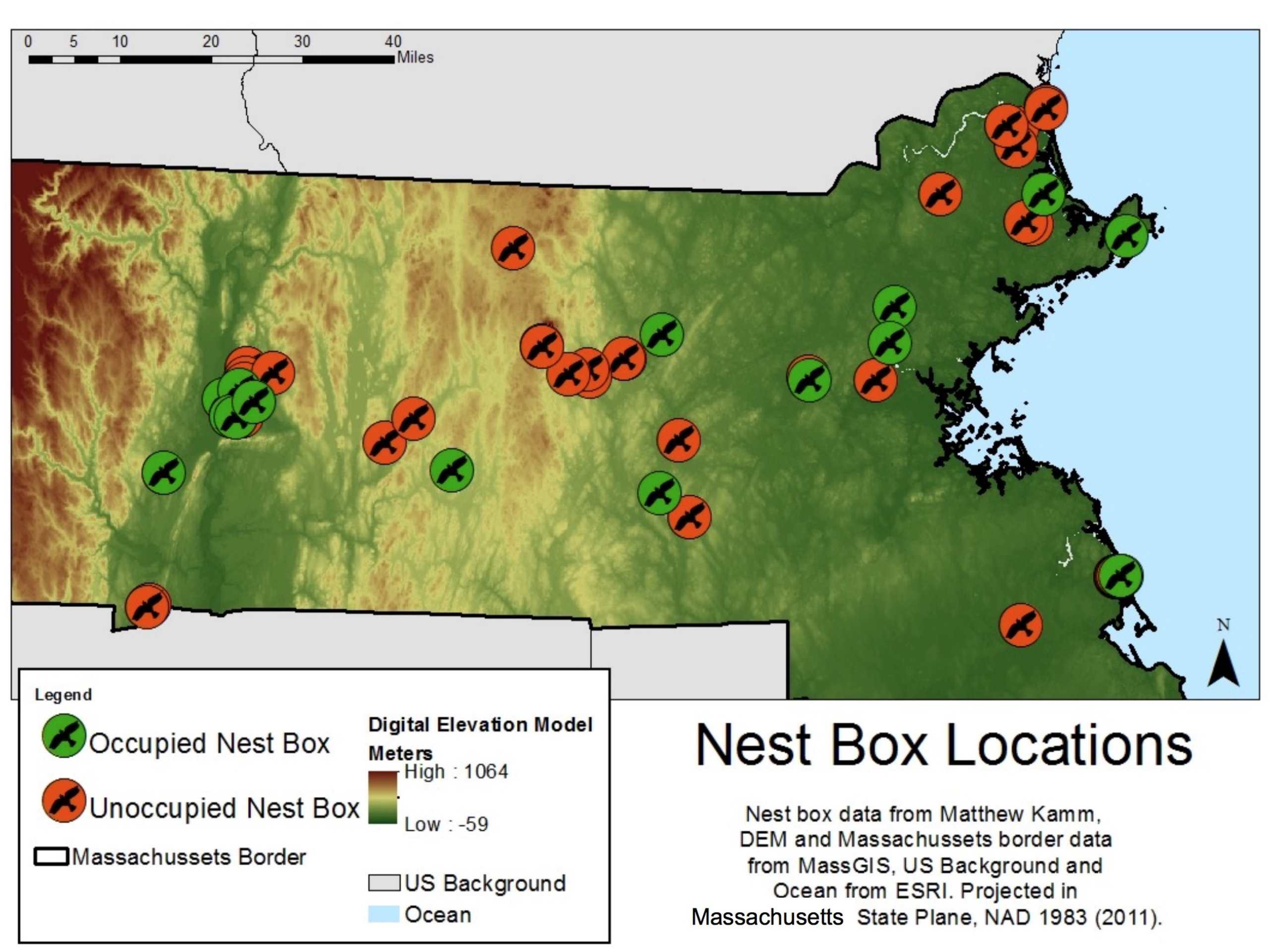
The Effect of Solar Radiation on the Success of American Kestrel Nest Boxes

Introduction

An integral part of species conservation is ensuring the availability of resources that the species will use through all stages of their life cycle. With proper habitat and food availability species can survive and reproduce to create a stable population. For birds, one of these habitat considerations is the microhabitat required for nesting. The American Kestrel (*Falco sparverius*) is a small migratory raptor that is often found in open areas like meadows and farms (Smallwood and Bird 2002). They hunt for rodents in these open areas and nest only in cavities, such as those created by woodpeckers (Smallwood and Bird 2002). In recent years their numbers have been declining across much of North America (Smallwood et al. 2009), so finding effective strategies for their conservation is especially imperative. Previous research has documented the effectiveness of human-built nest boxes in supporting local kestrel communities (Smallwood et al. 2009). Since kestrel populations are potentially limited by nest-site availability (Smallwood and Bird 2002), placing nest boxes in areas of suitable habitat may be of use in supporting at least the baseline habitat parameters needed. Microhabitat requirements in nest box placement may important for their success however (Rohrbaugh and Yahner 1997). Rohrbaugh and Yahner (1997) found that among other things, light-intensity in the nest boxes may influence whether or not they are used. In addition, it has been suggested that high light-intensity in the mornings may correlate with nest-box success because of early morning warming (Balgooyen 1976, as cited by Rohrbaugh and Yahner 1997). Using data collected on nest box success, I studied if solar radiation levels on the nest differ significantly between occupied and unoccupied nests for a whole day and for the first 4 hours of the morning.

Methodology

Nest box locations and success were collected in the field in the summer of 2014 by Matthew Kamm. A digital elevation model (DEM) was collected for Massachusetts from MassGIS. I used the Area Solar Radiation Analysis available in the Spatial Analyst Tools on ArcGIS as suggested by the Yale University Center for Earth Observation (see citation). A 15-meter buffer around each nest site was created in the DEM, and solar radiation for either all of June 21 or 5 AM to 9 AM on June 21 was calculated from that. I chose June 21 because of its proximity to the summer solstice where light intensities would be higher throughout the day. In addition, this time is right in the middle of the period when the young are in the nest (Smallwood and Bird 2002), so warmth of the nest may be especially important. The radiation values (in watt-hours/square meter) for each nest point was collected. Since the data were shown in SPSS (IBM Corp. 2015) not to follow a normal distribution, I completed a non-parametric Mann-Whitney test to test for significance between occupied and unoccupied nest sites for 24 hour and morning radiation.



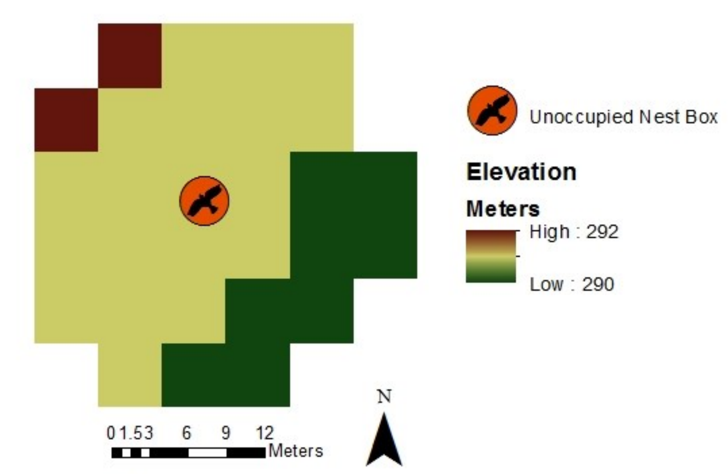
Nest Box Locations

Nest box data from Matthew Kamm, DEM and Massachussets border data from MassGIS. US Background and Ocean from ESRI. Projected in Massachusetts State Plane, NAD 1983 (2011).

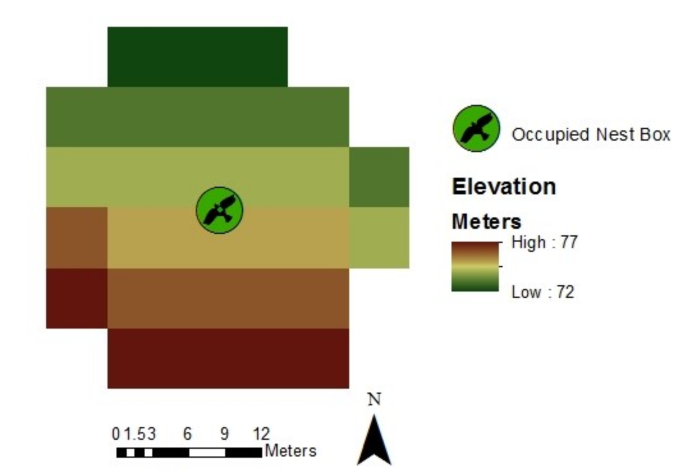
Analysis and Limitations

These data show no significant difference between solar radiation intensity in occupied nests and solar radiation intensity in unoccupied nests over a 24 hour period (Mann-Whitney test U= 275.00, n_1=15, n_2=38, p=0.843). There was also no significant difference between solar radiation intensity in occupied nests and solar radiation intensity in unoccupied nests in the first 4 hours of the morning (Mann-Whitney test U=256.00, n_1=15, n_2=38, p=0.567).

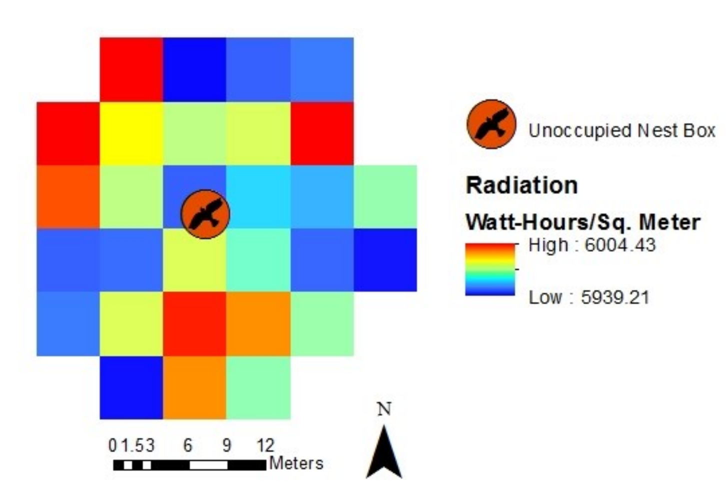
This can mean one of a few things. Firstly, it may be that kestrels aren't choosing nest sites based upon light intensity. Yet this study may not tell the whole story for a few reasons. Firstly, the study size was relatively small, with only 15 occupied sites and 38 unoccupied sites. Expanding the sample size may increase the reputability of this study. Secondly, the solar radiation calculation may change if the buffer size around the nest is expanded. Since solar radiation is calculated using the DEM at hand, a larger elevation model around each nest may show features this study is missing. Thirdly, while I chose light-intensity on June 21, relative values of radiation may change from the time the adults migrate in or choose nest sites. Lastly, and perhaps most importantly, I wonder if radiation intensity as measured on an elevation model have any significant effect on actual radiation received in a location as small as a nest box. Light intensity is likely determined by tree cover and distance from buildings, which are things that can't really be shown on a 5m x 5m DEM. Smaller scale analysis may be of use in correcting this issue.



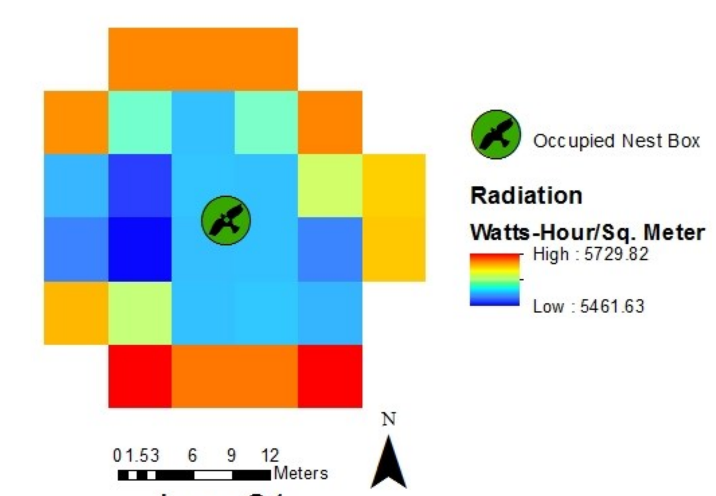
Elevation



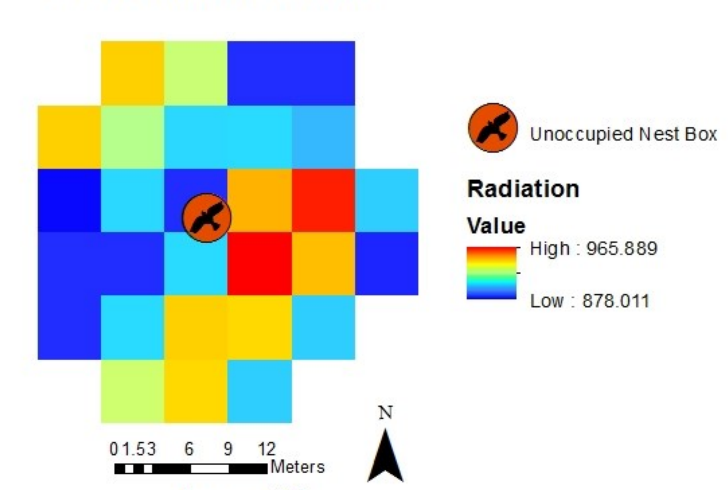
Elevation



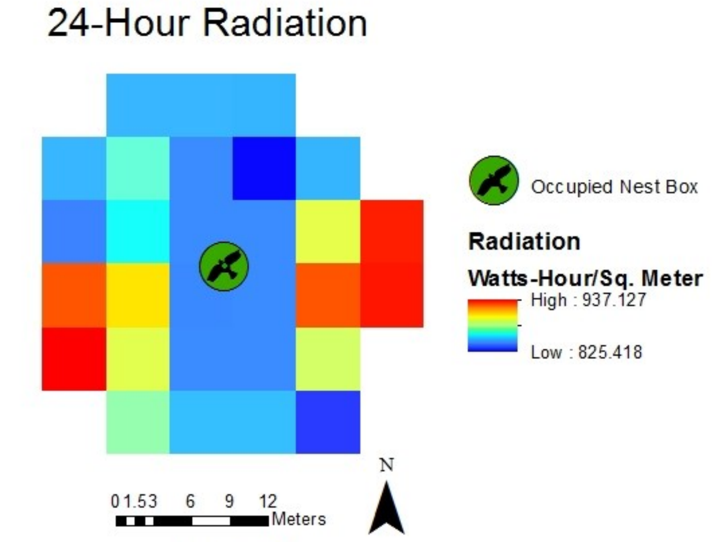
June 21
24-Hour Radiation



June 21
24-Hour Radiation



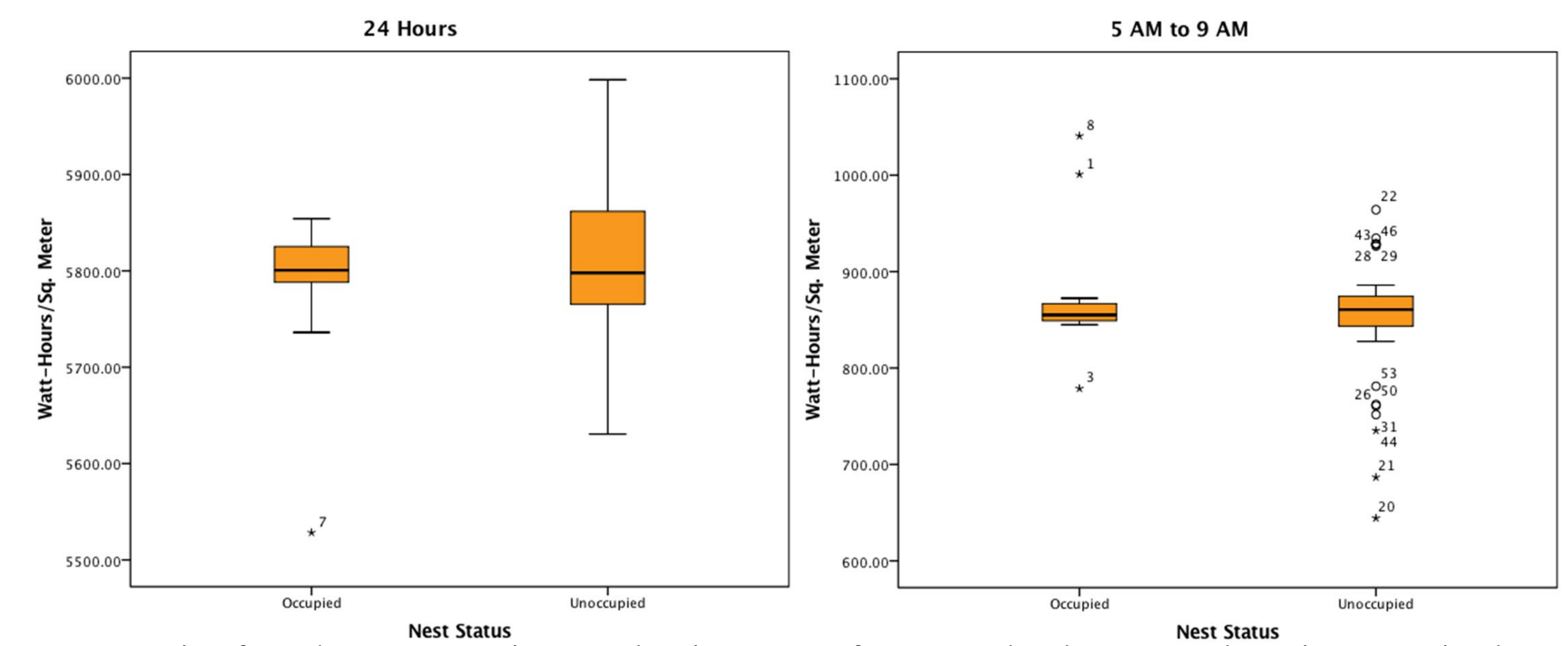
June 21
Radiation from 5 AM to 9 AM



June 21
Radiation from 5 AM to 9 AM

Conclusions

While no significant relationships were found between light-intensity and the nesting success of American Kestrel nest boxes, these types of studies should continuity to be done. For this issue, there may be a permutation of light-intensity yet to be studied that may impact nesting success. In general however, microhabitat studies are incredibly important tools for the implementation of successful conservation initiatives.



Boxplots for radiation over 24 hours and in the morning for occupied and unoccupied nest boxes. Circles denote data points more than 1.5 IQR but less than 3 IQR from median, asterisks denote points more than 3 IQR from median. Boxplots created by SPSS.

An American Kestrel (*Falco spurverius*)

Photo by Andy Morffew: Morffew, Andy. *American Kestrel (Male).* 2012. *Flickr.* Web. 17 Dec. 2015. <https://www.flickr.com/photos/andymorffew/8238822396>.

Resources

Created by Ethan Freedman

December 18th, 2015

GIS 101: Intro to GIS, Fall 2015

All maps projected in Mass. State Plane NAD 1983

Balgooyen, T.G. (1976). Behavior and ecology of the American Kestrel (*Falco sparverius*) in the Sierra Nevada of California. *University of California Publications in Zoology* 103, 1-83.

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MassGIS DEM - 2005, MassGIS Outline/Border - 1991
Nest Box data collected by Matthew Kamm in 2014
US Basemap/Ocean from ESRI.