

THE EFFECTS OF ANTHROPOGENIC LIGHT ON MIGRATORY BIRDS

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ABSTRACT

All over the world there has been an expansion of light pollution. As light pollution increases, scientists begin to wonder whether this can have a negative impact on a bird's migration pattern. We hypothesized that there would be more mortality rates of the genus *Ammodramus* as light scores of structures increased. We looked at two factors, light scores ranging from 1-10 would be the lower light levels, and light scores ranging from 10-20 were higher light levels. Our results reveal that mortality rates correlate with light scores. This means our hypothesis can be supported.

Key Words: Anthropogenic light, light scores, Ammodramus (nelsoni, leconteii, henslowii, savannarum), mortality

INTRODUCTION

Anthropogenic light is suspected to exert profound effects on many taxa, including birds. In the United States, roughly 1 billion birds die per year due to collisions with infrastructures (American Bird Conservancy, 2020). These effects may cause immediate changes to bird movement, habitat selection and settlement, and will alter bird distribution at larger scales. Buildings, especially those made from glass, reflect landscapes that can confuse birds during migration and cause them to collide with structures. When migrating, birds use magnetic fields to navigate, however, artificial light affects a bird's magnetic field sensitivity and therefore serves as a distraction (Michigan 2019).

Over the last 150 years, it has been reported that artificial sources of light can attract birds crossing the sea at night as well as nocturnally foraging seabirds (American Bird Conservancy, 2020). Artificial light creates powerful, disruptive and widespread effects on nocturnally migrating birds and other organisms through phototaxis, in which birds are drawn towards light sources. This behavior causes mortality through collisions. Scientists stated that when birds fly at higher altitudes, they are less likely to be distracted, instead of at lower altitudes (Michigan 2019).

The dataset that we reviewed, collected migratory information from Chicago, Illinois and Cleveland, Ohio. We focused on the genus *Ammodramus* because we wanted to narrow our data to a white-throated sparrow. Light scores and the number of bird collisions were recorded for each day. We hypothesize that since migratory birds are attracted to artificial light, then the migratory birds should be attracted to buildings with a higher light score, resulting in more collisions (with a higher death rate). The study conducted mostly looked at different passerine birds and stood in contrast to look over 10,000 white-throated sparrows.

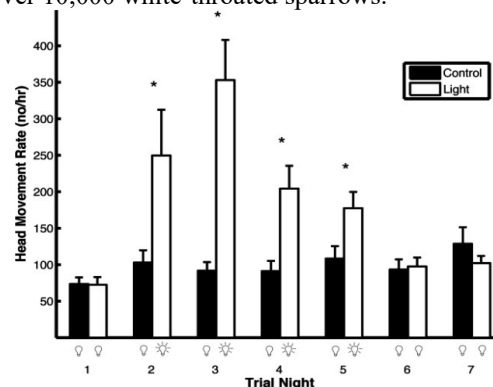


Figure 1. A bar graph showing that an increase in artificial light increases nocturnal vigilance. (Yorzinski J. et al., 2015)

METHODS

Collision sampling was gathered throughout 15 years, from 2000-2015, at McCormick Place in downtown Chicago, Illinois as well as in Cleveland, Ohio. The study examined records of lethal building collisions of passerine birds from both study sites at any time period throughout the 15 years. More than half of the Chicago collision records were collected around the perimeter of McCormick Place convention centre. Through observational skills, the researchers walked around the building looking for bird carcasses. Night-time lighting was recorded at McCormick Place in Chicago, Illinois based off of 17 windows that were illuminated. Researchers tallied up the number of bird collisions each day for which there were light scores (Winger, B. M et. al, 2019).

RESULTS

Table 1 and Table 2 break down bird collisions based on light scores 1-10 and 10-20 in Chicago, Illinois and in Cleveland, Ohio. The data looks at the four different species *nelsoni*, *henslowii*, *leconteii* and *savannarum* in the genus *Ammodramus*. Figure 2 displays the overall percentage of bird collisions into three sections of light scores 1-10, 10-20 and unknown. Out of the total 36 birds, 64%

collided with a building at a light score ranging from 10-20, 31% collided at a light score from 1-10, and 5% is unknown data. As seen in figure 3, *Ammodramus nelsoni* collided with a building 67% of the time when light scores ranged from 10-20. When light scores ranged from 1-10, collisions dropped to 33%. Figure 4 shows *Ammodramus henslowii*, out of the 4 birds, half collided when light scores ranged from 10-20 and the other half when light scores ranged from 1-10. Figure 5 displays *Ammodramus leconteii*, 90% of the birds collided when light scores ranged from 10-20, and 10% collided at a light score range from 1-10. The last bird was *Ammodramus savannarum*, there were 4 birds recorded and half of them collided at a light score from 1-10 and the other half of the data is unknown.

Using a Chi-Square goodness of fit test, the data reveals that there was a correlation between light levels and mortality rates in the genus *Ammodramus*. As light scores go up (range 10-20), mortality rates increase, and as light scores go down (range 1-10), mortality rates decline. The results of the Chi-Square goodness of fit test are shown in table 3 and table 4. The Chi-Square goodness of fit test was used to compare light levels in the Chicago data with bird collisions, since there was more data to work with. The Chi-Square goodness of fit test had a p-value of 0.013. This p-value is lower than 0.05 therefore there is a correlation in which birds will collide with buildings when artificial light levels are higher rather than when they are lower.

CHICAGO:

Table 1: Results from the Chicago study that examines three different species in the Genus *Ammodramus* and displays information on date of death, location and light scores ranging from 1-20.

Genus	Species	Date	Location	Light Score
Ammodramus	nelsoni	2000-05-14	MP	9
Ammodramus	nelsoni	2000-09-13	MP	16
Ammodramus	nelsoni	2000-09-21	MP	4
Ammodramus	nelsoni	2000-10-03	MP	14
Ammodramus	nelsoni	2000-10-11	MP	16

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Ammodramus	nelsoni	2004-05-18	MP	15
Ammodramus	nelsoni	2004-10-02	MP	14
Ammodramus	nelsoni	2005-09-28	MP	17
Ammodramus	nelsoni	2006-09-20	MP	15
Ammodramus	nelsoni	2007-05-20	MP	15
Ammodramus	nelsoni	2009-10-04	MP	4
Ammodramus	nelsoni	2010-09-30	MP	4
Ammodramus	nelsoni	2012-09-18	MP	17
Ammodramus	nelsoni	2013-05-18	CHI	6
Ammodramus	nelsoni	2014-09-21	MP	14
Ammodramus	nelsoni	2014-10-04	MP	16
Ammodramus	nelsoni	2014-10-04	MP	16
Ammodramus	henslowii	2005-04-19	CHI	17
Ammodramus	henslowii	2010-05-11	CHI	14
Ammodramus	henslowii	2012-05-25	CHI	4
Ammodramus	henslowii	2015-04-29	CHI	3
Ammodramus	leconteii	2000-10-27	MP	17
Ammodramus	leconteii	2002-05-06	MP	17
Ammodramus	leconteii	2004-10-14	CHI	17
Ammodramus	leconteii	2005-09-14	CHI	16

DOI

Ammodramus	leconteii	2006-10-30	CHI	17
Ammodramus	leconteii	2011-10-11	MP	17
Ammodramus	leconteii	2012-09-29	CHI	12
Ammodramus	leconteii	2012-10-04	CHI	14
Ammodramus	leconteii	2012-10-15	MP	13
Ammodramus	leconteii	2014-05-09	MP	4
Ammodramus	nelsoni	2005-10-06	CHI	9

CLEVELAND:

Table 2: Results from the Cleveland study that examines four species in the Genus Ammodramus and displays information on date of death, location and light scores ranging from 1-20.

Genus	Species	Date	Light Score
Ammodramus	savannarum	2010/6/17	N/A
Ammodramus	savannarum	2010/10/17	7
Ammodramus	savannarum	2010/06/17	N/A
Ammodramus	savannarum	2005/10/18	8

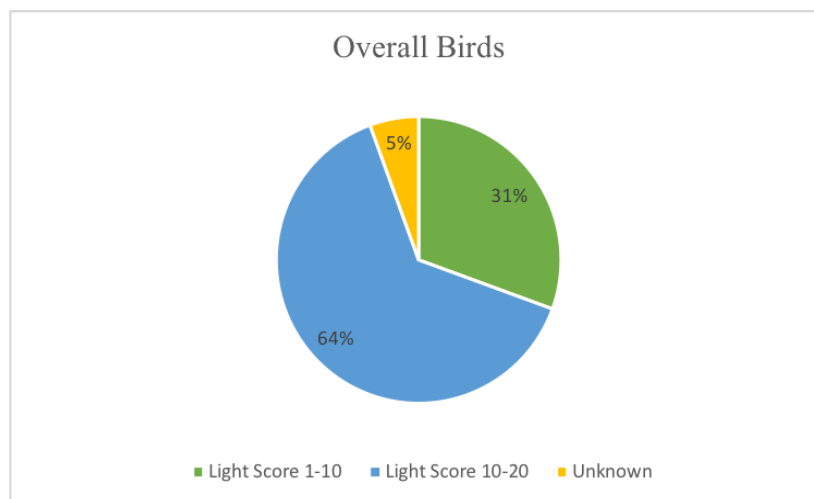


Figure 2: Pie chart showing overall percentage of all 36 birds collisions based on light scores 1-10, 10-20 and unknown information. 64% of the mortality rates occurred at the light score from 10-20 were 23 birds, 31% of the mortality rates occurred at the light score from 1-10 were 11 birds and the 5% of the mortality rates occurred at unknown ranges were 2 birds.

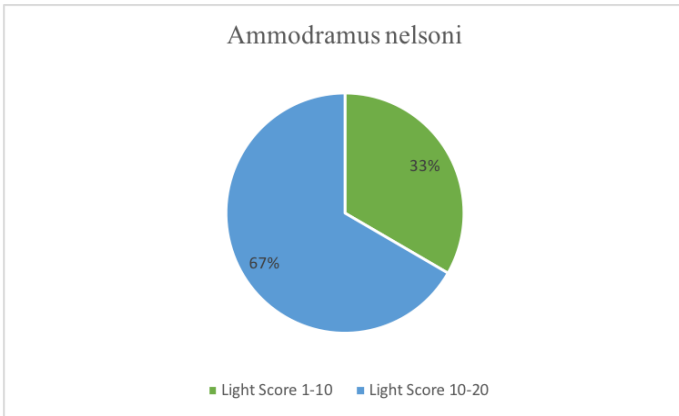


Figure 3: Pie chart showing 18 of the species *Ammodramus nelsoni* collisions based on light scores 1-10 and 10-20. 33% of the mortality rates occurred at the light score from 1-10 were 6 birds. 67% of the mortality rates occurred at the light score from 10-20 range were 12 birds.

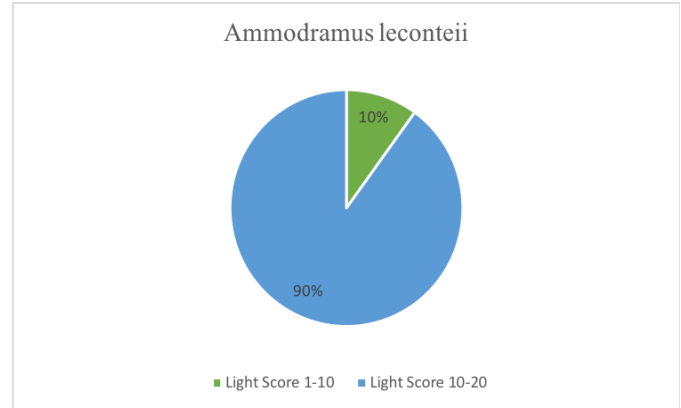


Figure 4: Pie chart showing 10 of the species *Ammodramus leconteii* collisions based on light scores 1-10 and 10-20. 10% of the mortality rates occurred at the light score from 1-10 was 1 bird. 90% of the mortality rates occurred at the light score from 10-20 range were 9 birds.

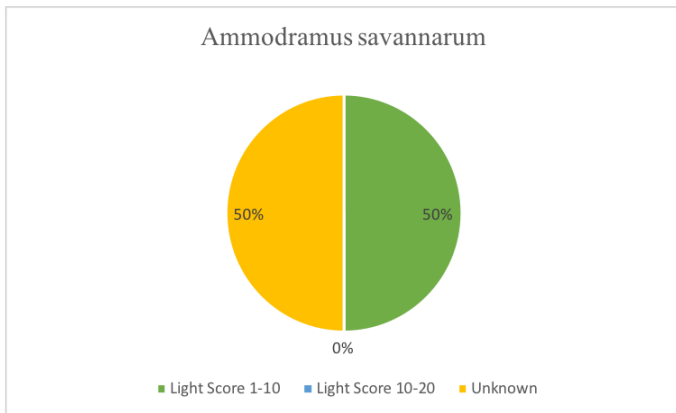


Figure 5: Pie chart showing 4 of the species *Ammodramus savannarum* collisions based on light scores 1-10, 10-20 and unknown. 50% of the mortality rates occurred at the light score from 1-10 were 2 birds. 50% of the mortality rates occurred at the light score from unknown were 2 birds.

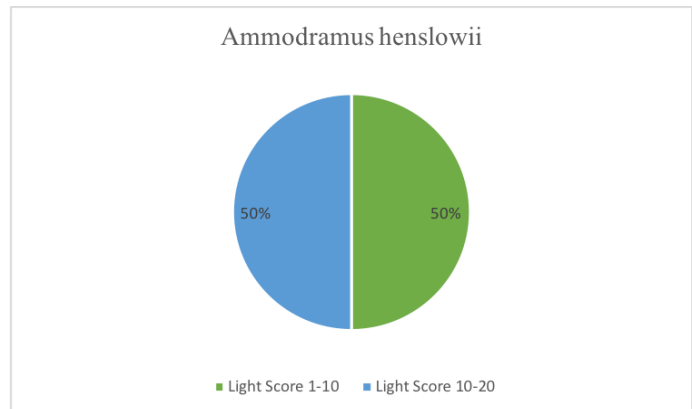


Figure 6: Pie chart showing 4 of the species *Ammodramus henslowii* collisions based on light scores 1-10 and 10-20. 50% of the mortality rates occurred at the light score from 1-10 were 2 birds. 50% of the mortality rates occurred at the light score from 10-20 range were 2 birds.

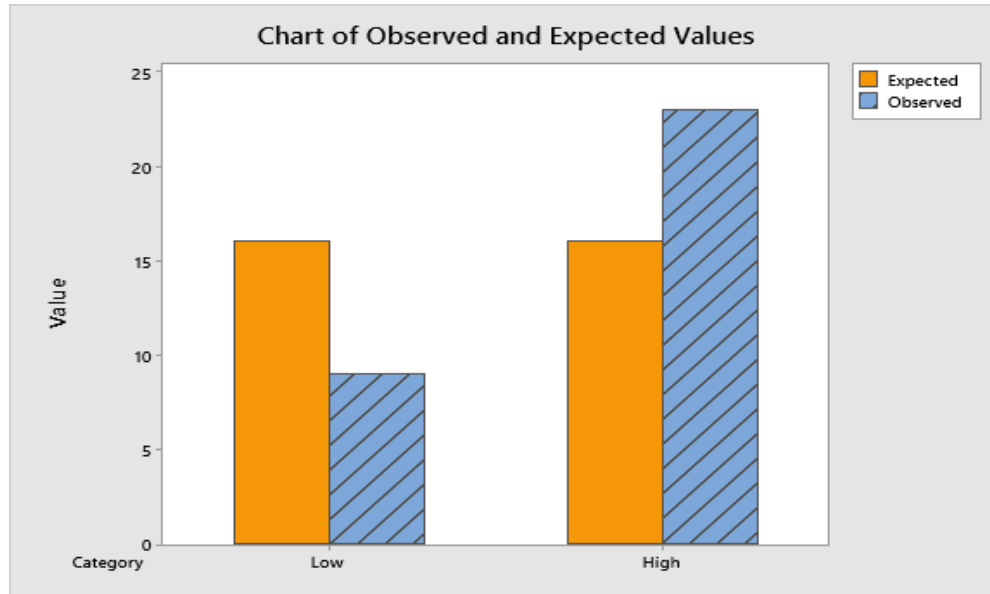


Figure 7: Bar graph comparing the expected counts to observed counts of collisions against Low and High light scores.

Table 3: Chi-Square goodness of fit test comparing the expected and observed counts of Low and High light levels during collisions.

Observed and Expected Counts

Category	Observed	Test Proportion	Expected	Contribution to Chi-Square
Low	9	0.5	16	3.0625
High	23	0.5	16	3.0625

Table 4: Chi-Square goodness of fit test showing the P-Value of collisions.

Chi-Square Test

N	DF	Chi-Sq	P-Value
32	1	6.125	0.013

DISCUSSION

Our results revealed that the majority of bird collisions occur when the artificial light levels ranged from 10-20. When artificial light scores ranged at higher levels, more than 50% of the genus

Ammodramus collided with structures. Figure 2 revealed that 64% of the overall 36 birds collided with buildings when the light score was at its highest, ranging from 10-20. According to studies, migration for a bird at night can easily be altered by the artificial lights. It has been suggested that when birds fly into lights at night, the bird then loses its visual cues to where the horizon is and where the moon and stars are to help with migration. Since the birds use the horizon to help with migration, the use of artificial lights create spatial disorientation for them. Focusing on the lighted structure causes the bird to be temporarily blinded and disoriented and therefore are captured by the only thing that stands out against darkness (Rich, 2013).

Overall, our results show that there is a correlation between artificial light scores and mortality rates in the genus *Ammodramus*. Additional studies on this subject can be done by seeing the effects of weather on migration patterns and collisions. Along with this, more research can be performed to investigate how flight call behavior affects migration patterns and how this affects bird mortality rates with building collisions.

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