The Effect of Light Pollution on the Biodiversity of Nocturnal Insects in Lynbrook

Cold Spring Harbor Laboratory DNA Learning Center

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Introduction

- Sports light disturb the activities of nocturnal organisms
  - Habitat formation, migration patterns, circadian rhythm, and more are impacted
  - Additionally, sports lights interfere with interactions between organisms

Abstract

Many nocturnal organisms are sensitive to light during the nighttime hours. Numerous fields across Long Island use sports lights to illuminate fields. These sports lights cause light pollution which can negatively affect nocturnal organisms' daily cycles, which could affect the biodiversity of nocturnal organisms on Long Island. It is hypothesized that if the amount of artificial light is increased, then the biodiversity of nocturnal organisms decreases, based on the principle that artificial light is harmful to populations of nocturnal organisms. Two schools in the Lynbrook School District have varying amounts of light pollution. These two schools, West End Elementary School, and North Middle School, will be used to collect samples of moths. The data will be analyzed by calculating the Simpson's Diversity Index for both locations.

Background

- Certain nocturnal organisms, like moths are bioindicators
  - Bioindicators can help to determine the health of a natural ecosystem
- Light pollution determined based on presence or absence of sports lights
  - North Middle School, shown in figure 1 as the red dot, has high light pollution relative to West End Elementary School
  - North Middle School has had sports lights for over one year, and they are used during sports practices and other events during the non-daylight hours
  - West End Elementary School, shown in figure 1 as the green dot, does not have any sports lights on the premises, making it a location with relatively low light pollution

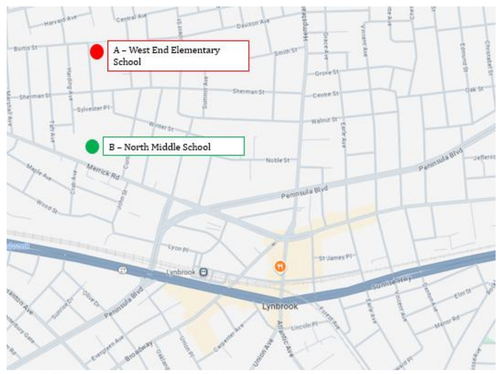

Figure 1 – This image a map of Lynbrook, with West End Elementary School, and North Middle School highlighted in red and green respectively. These were the two locations used in this experiment. This is a student generated image.

Hypothesis

- If the amount of artificial light is increased, then biodiversity of nocturnal insects decreases
  - Artificial light is harmful to the populations of nocturnal organisms and their mechanisms of sight during the dark hours

Methodology

- Locations were selected
  - West End Elementary School & North Middle School were utilized
  - West End Elementary School does not have any sports lights on the premises, making it a location with low light pollution
  - North Middle School is a location that has had sports lights for over a year, making it a location with high light pollution
- Katchy Insect Trap deposited at locations
  - Bright light emitted from the top of the trap attracts nocturnal organisms to the fan inside the trap
  - Fan inside the trap keeps insects from exiting the trap
  - Organisms caught in collection plate beneath fan inside the trap, as shown in figure 2

Figure 2 – This image displays one of the Katchy Insect Traps deposited at the location with very little light pollution, West End Elementary School. This is a student generated image.

Figure 3 – This image serves as an example of a high-definition image of the top of a sample. This is sample 013. This is a student generated image.

- Documentation of samples
  - High-definition photos of the top, bottom, and full body of the insects were captured, as shown in figures 3 and 4
  - Ruler included in images for size reference
  - Each sample was assigned a three-digit code (ex. 022)
- Visual sample identification
  - Resources like iNaturalist were employed to identify the samples.
  - Multiple high-definition images were uploaded to iNaturalist where other scientists identified the insects
- Data Analysis
  - After compiling the data from iNaturalist, pie charts were made to display how each location was divided up in terms of the organisms collected
  - Simpson's Diversity Index was calculated for each location to further get a better understanding of the biodiversity of each location

Figure 4 – This image serves as an example of a high-definition image of the top of a sample. This is sample 022. This is a student generated image.

Sample Collection → Katchy Insect Trap

Sample Documentation → Dissecting Microscope

Visual Identification → Upload to iNaturalist

Data Analysis → Pie Chart

Results & Discussion

- Frequency of different species found at each location
  - Of all the samples collected at West End Elementary School, the most ubiquitous were crane flies, as shown in figure 5
  - Of all the samples collected at North Middle School, the most ubiquitous were mosquitoes, as seen in figure 6

Location	Mosquitoes	Crane Fly	Hanging Fly	Midges	Nematoceran Flies	Simpson's Diversity Index Value
West End	3	6	1	0	0	0.60
North Middle	6	1	0	2	3	0.71

Figure 7 – This figure is a table displaying the different species & frequency of each species found at North Middle School, the location with low light pollution. This table is used to figure out the Simpon's Diversity Index value for each location. This is a student generated figure.

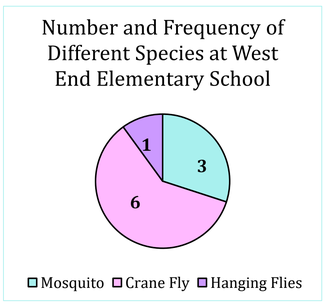

Figure 5 – This figure is a pie chart displaying the different species & frequency of each species found at West End Elementary School, the location with low light pollution. This is a student generated figure.

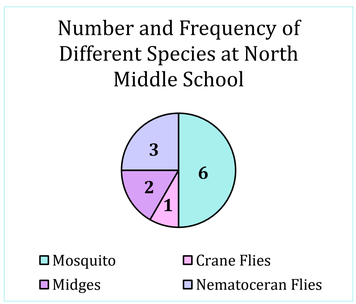

Figure 6 – This figure is a pie chart displaying the different species & frequency of each species found at North Middle School, the location with low light pollution. This is a student generated figure.

- Simpson's Diversity Index Calculation
  - The Simpson's Diversity Index provides a rough numerical value for the biodiversity of each location
  - The formula for Simpson's Diversity Index is shown below in figure 8 where the number of species and the frequency of each species is considered
  - According to the Simpson's Diversity Index, North Middle School has a higher biodiversity. This is shown in figure 7

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

Figure 8 – This figure is the formula for Simpon's Diversity Index. This is a student generated figure.

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Conclusion

- Stadiums are becoming more prominent
  - The pollution emitted from those stadiums greatly impacts the natural ecosystems in the area
- Higher Simpson's Diversity Index at location with higher light pollution
  - A Simpson's Diversity Index value of 0.60 was found for West End Elementary School, the location with low light pollution
  - A Simpson's Diversity Index value of 0.71 was found for North Middle School, the location with high light pollution
- Seasonal biodiversity changes impacted results
  - The time of data collection, the winter, could have played a role in the biodiversity since certain species are not found in the colder months
  - For example, crane flies are more prominent in the winter months, which explains why there was a large amount of crane flies collected

Future Research

- Data collection over multiple seasons
  - More samples would be collected during the Spring and Summer seasons
  - Certain species like crane flies are more prominent during colder seasons, which affects biodiversity
- Greater magnitude of light pollution
  - Locations with a greater amount of light pollution, like a stadium would be utilized
  - Additionally, a wider range of light pollution would be included, such as locations with sports lights for less than a year

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