



An Analysis of Photic Flashing in *Photinus pyralis* to Light Pollution and Select Weather Parameters

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Abstract

Fireflies begin their mating season during early to mid-June in Southeastern Michigan but exact phenology varies year to year due to atmospheric, hydrologic, and other seasonal variations. Fireflies from two sites were sampled prior to beginning data collection in order to identify the specific species used throughout the research. After observing the firefly phenology, both specimens were identified as *Photinus pyralis*, a species indigenous to Southeast Michigan. Data collection began on June 18th, 2018 at two separate study sites. Site 1 was on a brightly illuminated main road located in a suburban neighborhood. Site 2 was farther off in a secluded area near a large grouping of mature trees, and where a significantly less amount of light pollution was evident. A variety of GLOBE weather data was collected daily including air temperature, air pressure, daily rainfall, humidity, etc., along with readings of light pollution using a “Sky Quality Meter (measures the brightness of the night sky in magnitudes per square arcsecond). Researchers would head out daily to count the number of flashes and record GLOBE data around dusk. Information was then entered into the GLOBE database website and entered onto an Excel spreadsheet for future reference. An analysis of the data found a positive correlation between firefly flashes and light pollution, humidity, temperature, and precipitation. Fireflies were chosen for this research because of their potential sensitivity to light pollution and climate change. It’s hoped that this research can serve as a benchmark for local studies to see how populations of similar species might be impaired by habitat and climate change. For future references, it would be better to find a way to count the actual number of fireflies in each site as opposed to evaluating their flashing activity, allowing us to precisely pinpoint where population densities are present.



Research Questions

- Do select parameters such as light pollution, rainfall amounts, humidity, and temperature play a role in firefly population numbers or fewer firefly flashes?
- What could be the possible underlying causes of recent firefly decline in the past few years?
- How do these two select sites differ in select atmospheric parameters and firefly flashes?

Null Hypotheses

- Light pollution does not play a role in the decreased abundance and distribution of the *Photinus pyralis* firefly population.
- There is no difference between air temperature, humidity, light pollution between the two study sites.
- There is no difference between the firefly flashes between Site 1 and Site 2 on a daily basis.



Results

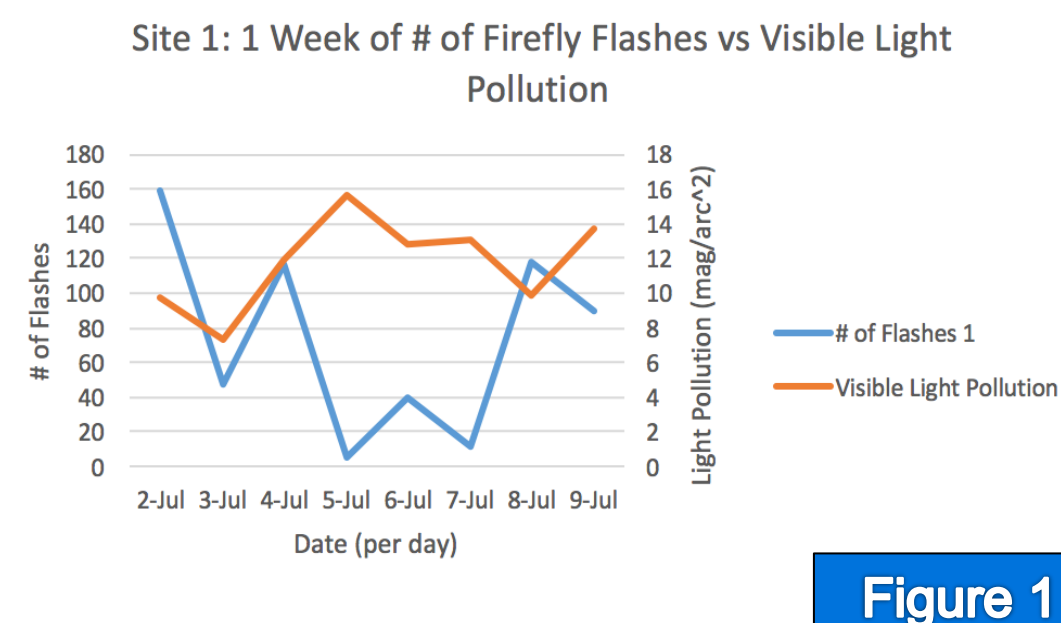


Figure 1

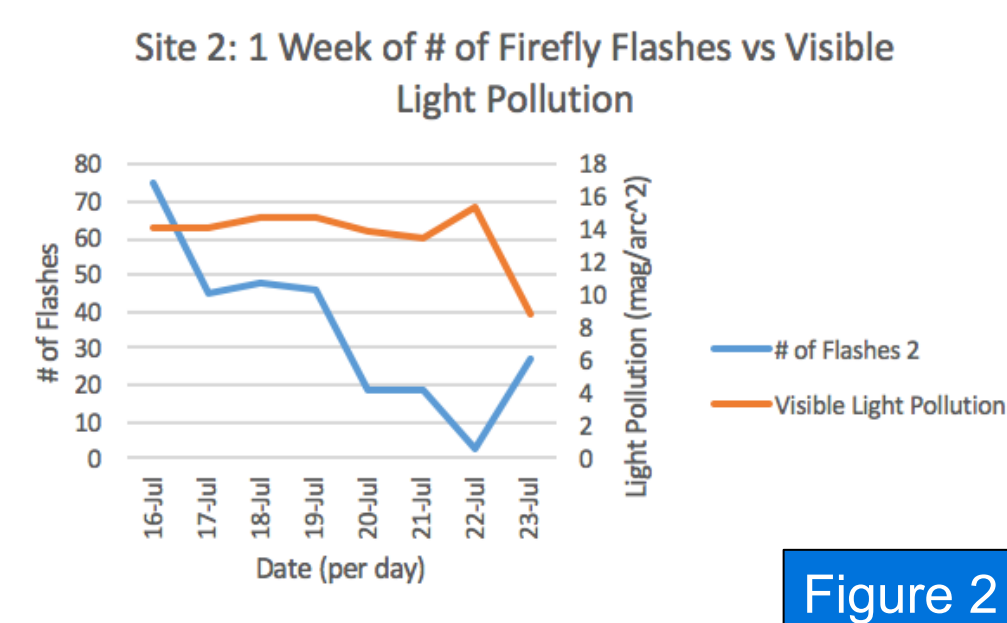


Figure 2

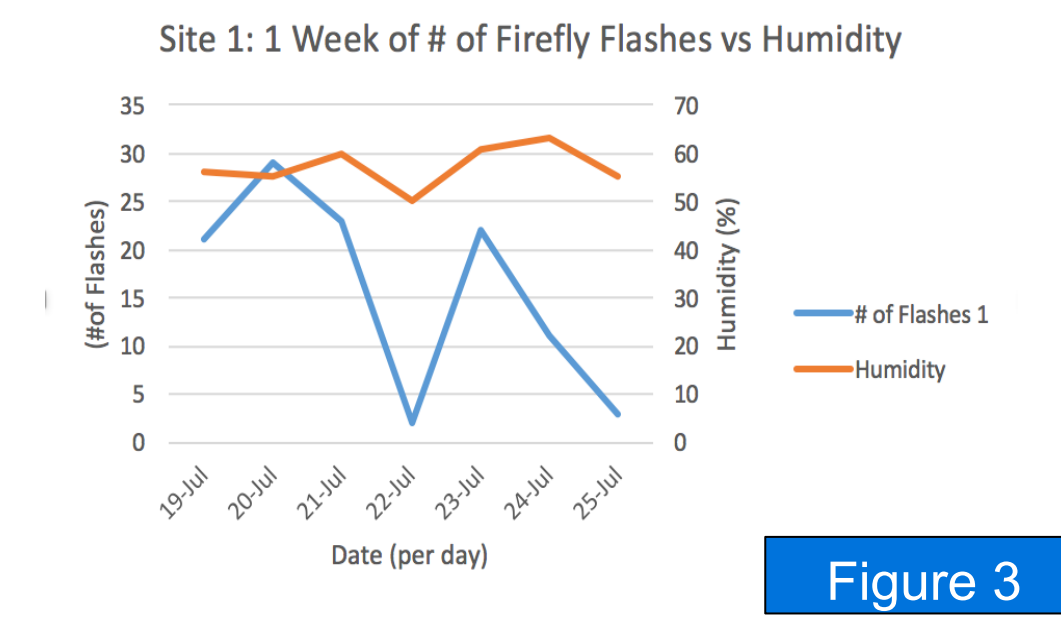


Figure 3

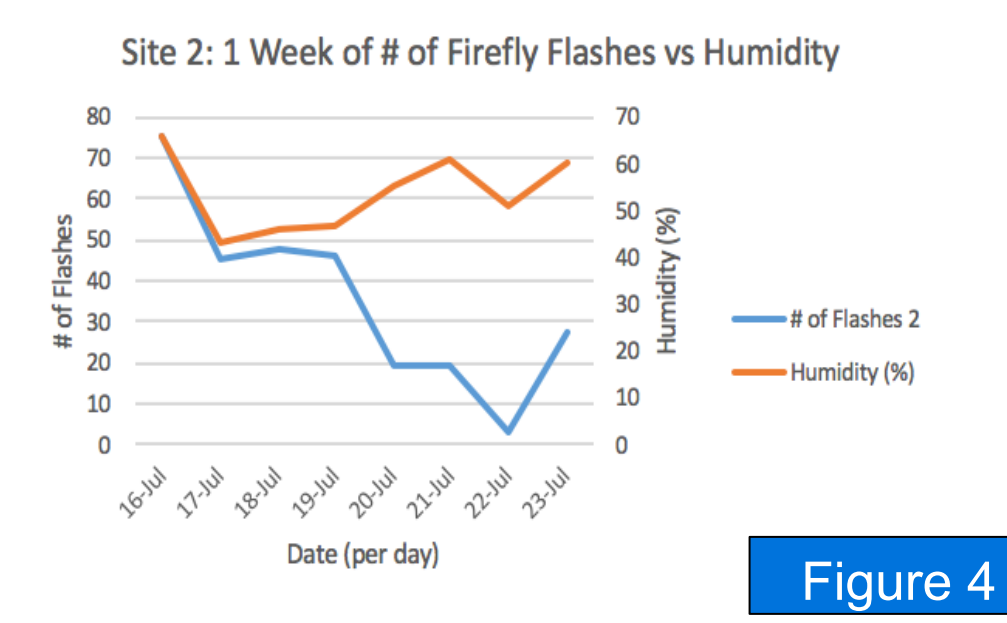


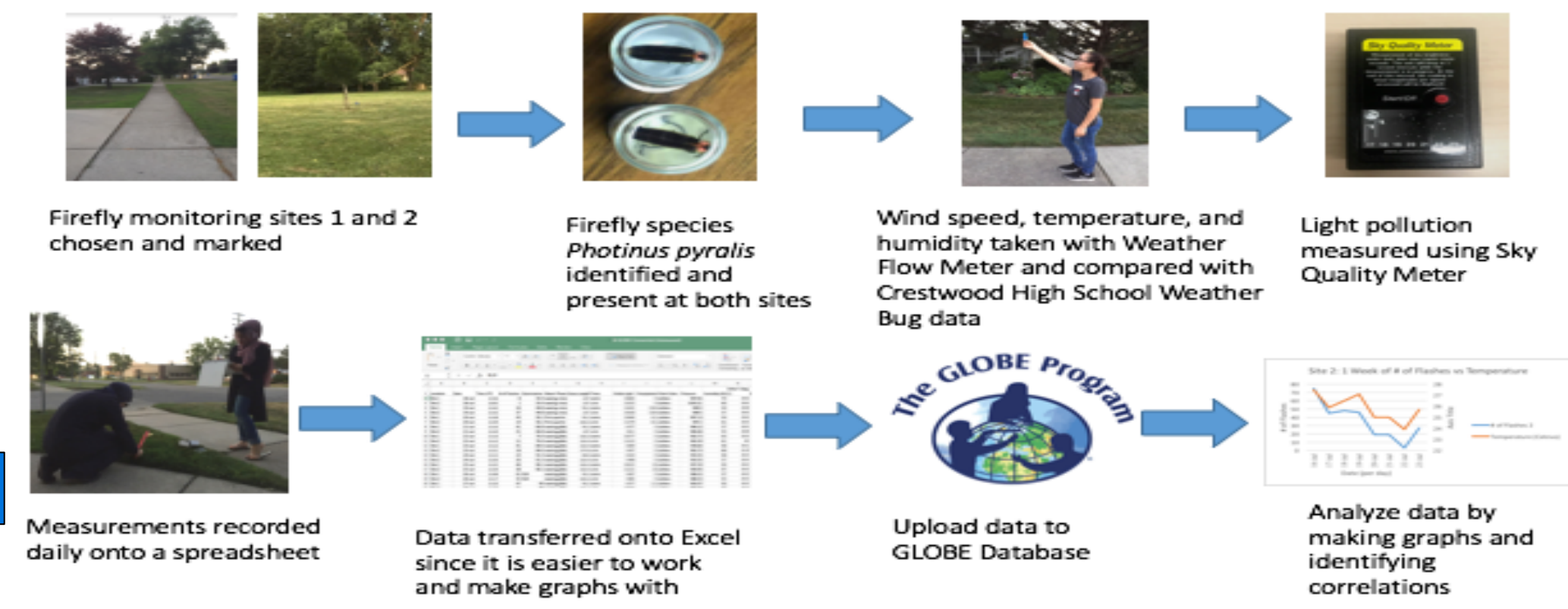
Figure 4

Both Figures 3 and 4 show a correlation between humidity and flashes in both sites. Humidity ranged from 50-70% and when humidity stayed at around 60%, the number of flashes shown seemed to increase a little. Humidity also kept at a range between 50-70% for Site 2. Furthermore, it seems as when the humidity stayed between 50-60%, the number of flashes seemed to spike up a little.

Research Implications

Continued firefly research is essential in determining the effects of humans on local, regional, and worldwide Lampyridae populations. A GLOBE protocol should be developed (much like the mosquito protocol) for monitoring firefly activity so that students around the world can assess whether these insect populations are truly declining or maintaining current levels. GLOBE protocols should also be created for light pollution as this has been found in many instances to affect fireflies and other nocturnal insect populations. By coming together as worldwide GLOBE community, we can begin accurately assess the effects humans are having on this ubiquitous and fun species. Many species of fireflies can be considered as bio indicators of environmental quality. Habitat loss, light pollution, disease, pesticides, and climate change are all often cited by researchers as reasons for the worldwide decline in fireflies as well as other species of insects. Many of the reasons for firefly decline may be synergistic in nature making their population losses even more difficult to study. Without solid data to support this perceived decline, it is essential that students from many different locations both in the U.S. and around the world collect data that can be analyzed empirically. The data collected from many parameters such as light pollution (using a Sky Quality meter), air temperature, humidity, or even lunar illumination will play a role in determining how fireflies are affected by human activity. Firefly flashes play a role in deciding around how many fireflies could be present that certain day. Although each firefly flashes many times and the number of flashes do not equate how large the population is, the flashes do provide a general indication of activity. The student researchers understand the data that they have collected, as these results could be used for further references by scientists to further reach a conclusion on whether the firefly population has been on the decline. Overall, this research could be used in the future to compare between other species’-including us!- biological clocks from the effect of light pollution. The additional air parameters could also be utilized in the future for aerosols as the student researchers even collected data on wind chill, wind speed, etc.

Methods



Conclusions

After gathering some measurements on air quality, humidity, temperature and even precipitation, significant differences can be seen between the two sites as Site 1-the site with artificial lighting and in a suburban neighborhood-had noticeably less firefly flashes as the second site. Thus, air quality or the light pollution in the two sites proved to be one of the driving factors in the abundance and distribution of fireflies. This rejects our null hypotheses as there was a noticeable difference in firefly flashes between the two sites as well as rejecting our first null hypotheses as light pollution seemed to have an effect. The second null hypotheses is also rejected as temperature and even humidity seemed to play a role in the lesser abundance of firefly distribution. As shown from Figures 11-12, observations were made that Site 2 may have had an increase in the number of flashes than Site 1 because of the greater magnitude the Sky Quality Meter picked up and also meaning that it was darker and less light-polluted. Humidity seemed to play a bit of a role in flash numbers as well because as shown in Figures 13-14, and increase in humidity overall generated a spike in numbers. Site 2 generally had a higher percentage of humidity and also a higher number of flashes than Site 1 giving way that keeping around 60% humidity helped keep the abundance of fireflies up. In addition, temperature also had a role in firefly abundance because as shown in Figures 17-20, an increase of firefly flashes seemed to generate from an increase/ constant temperature around 25°C. Precipitation could also have an impact on firefly flashes as well as there seemed to be a direct relationship between no occurrence of rain-more fireflies- and vice versa in both sites. The student researchers accept their hypothesis as air quality, humidity and other parameters could have an effect on the distribution and abundance of fireflies. Overall, this research could be used in the future to compare between other species’-including us!- biological clocks from the effect of light pollution. The additional air parameters could also be utilized in the future for aerosols as the student researchers even collected data on wind chill, wind speed, etc.

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