Determining an environmental predictor of butterfly abundance at the Beaverhill Bird Observatory

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Abstract

Data about butterfly populations has been collected in the form of annual surveys at the Beaverhill Bird Observatory (BBO) since the 1970s (Thormin 1977). This paper reports on the findings of these surveys in the summer of 2017. Pollard walks were used as the primary method of sampling butterfly population biodiversity and abundance. Butterfly species and population numbers were recorded alongside temperature, cloud cover, and wind speed data from when the survey was collected. The data was then analyzed to determine optimal weather sampling under which to perform butterfly surveys. Analyses were used to attempt to determine if one environmental factor could be used to predict general butterfly abundance on a survey but there was no strong correlation between any one environmental condition and butterfly abundance. Future directions for research in this area is suggested.

Introduction

Butterflies are invertebrates that everyone knows and are a species that many people associate with warm summer days. Beyond their aesthetic value, though, butterflies have many important ecosystem functions. According to the Butterfly Conservation Organization, butterflies are an indicator of a healthy ecosystem – the presence of butterflies indicates a broad range of other invertebrates. Monitoring butterfly populations as the climate changes will provide useful insight into how other invertebrates in a particular area are reacting to the change (Thomas 2005). Additionally, butterflies are an important part of an ecosystem as they pollinate plants, control pest insects, and are prey for birds and other vertebrates. Butterflies have been used frequently by ecologists as a model organism to study the effects of habitat fragmentation and loss, especially considering climate change (Butterfly Conservation Organization, England) – due to their sensitivity to the environment, butterflies are an excellent indicator of changing environmental conditions (Thomas 2005).

Butterflies are an important part of the ecosystem and an important part of scientific research, so it is important that surveys that are done to study butterfly abundance and biodiversity are done accurately and consistently. An important part of ensuring accuracy and consistency is understanding environmental factors that may influence the abundance of butterflies on a particular day. Butterflies are highly susceptible to environmental conditions (Rogers 2009) so researchers should fully understand which factors will affect their abundance on a particular day to ensure that results on butterfly abundance aren't under or over reported due to sampling day conditions.

For this report, I worked with my supervisor (Steve Andersen) to examine conditions under which butterfly collection was optimal. We considered what we determined as three key environmental conditions that could potentially influence butterfly abundance: temperature, cloud cover, and wind speed. Temperature was measured in degrees Celsius, cloud cover in percentage of sky covered, and wind speed using the Beauford scale. I will be examining the number of butterflies found across each of these variables to attempt to determine if there is an optimal set of conditions under which to find butterflies, even across different habitats. I will attempt to determine if there is one key environmental factor in predicting butterfly abundance during surveys, in hopes that the results found are useful for future butterfly researchers in determining the best days to sample butterflies.

Methods

The method used to gather information on butterfly species was the Pollard walk. These walks are a method that allows an observer to get a fairly accurate representation of butterfly biodiversity and abundance with weekly walks when temperatures are above a minimal threshold for butterfly activity (Pollard 1977). During a Pollard walk, the individual walks along a specified transect that is designed to coincide with changes in habitat, so multiple habitat types are surveyed. The observer then walks at a consistent pace, recording all butterflies they see around them, and stopping if necessary to ensure a correct species identification, but simply noting the species if the observer is confident in his or her identification. This method of transects is considered a robust one and involves minimal effort for the observer, as some butterflies can be difficult to catch and catching each butterfly can dramatically slow down a survey (Pollard 1977).

Pollard walks were performed along pre-determined routes once weekly by two observers (Maya Frederickson and Steve Andersen) from late April to early September 2017. On average, two surveys were performed per week between both observers, and 1-2 routes were performed per day. Generally, rainy days or days when the temperature dropped below 15℃ were avoided, as it was assumed there would be no butterfly sightings under such conditions. All routes were within one kilometre of the BBO and were chosen to include multiple habitat types – wetland, grass land, forest, and open areas – in the hopes of avoiding bias from on environment types. There were four different routes used throughout the summer in total.

At the start of each survey temperature, cloud cover, and wind speed was recorded. Throughout the survey, the surveyor would identify the butterfly in flight when possible and otherwise would capture the butterfly to photograph. Photographs were examined later to confirm species identification. Butterflies that escaped or could not be captured were simply recorded as “unidentified” and still counted toward the total number of butterflies seen during that survey. Identifications of butterflies were made using *Alberta Butterflies* (Bird et al. 1995), *Butterflies of Alberta* (Acorn 1993), and the online Canadian Biodiversity Information Facility (http://www.cbif.gc.ca/eng/species-bank/butterflies-of-canada/).

The species and number of butterflies was recorded in a spreadsheet along with environmental data from the day. The number of butterflies spotted and the environmental data was then analyzed using excel to examine if optimal butterfly conditions could be determined and if there was a key environmental factor that could be used to predict butterfly abundance.

Results

To begin, I examined the relationship between total sightings of butterflies and average temperature on the routes. Average temperature was determined simply as the average between the starting temperature noted before the survey was done and the finishing temperature noted when the survey was complete. Butterfly species, as well as the time of year, was not taken into consideration at this point. The graph produced was as follows:

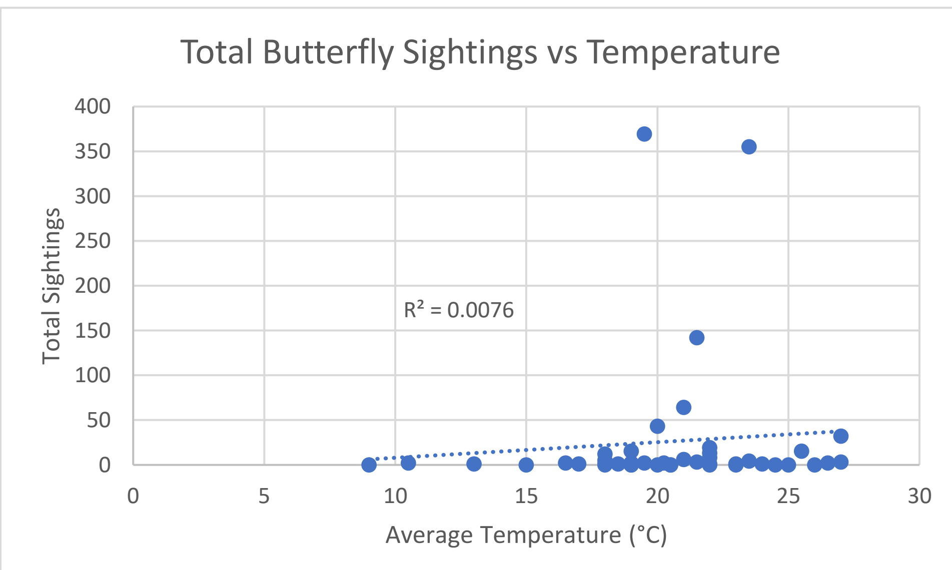
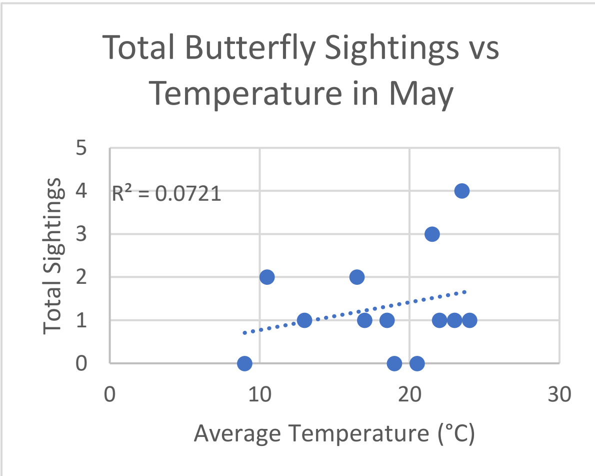
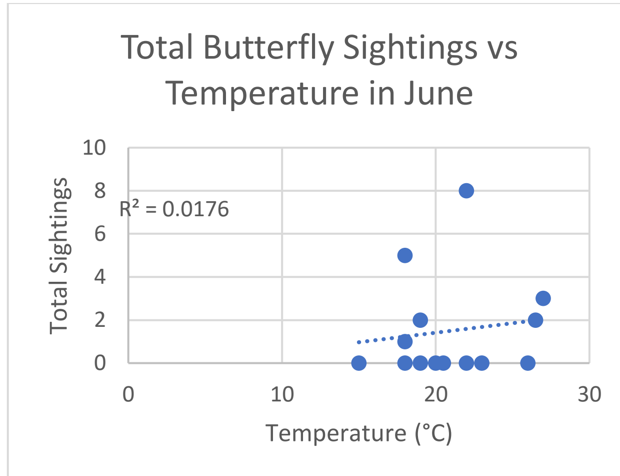


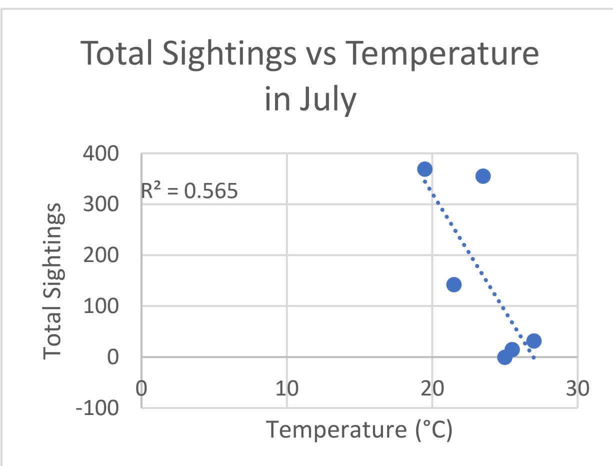
Figure 1. Total butterfly sightings expressed as a function of average temperature. The trendline shows a weak increase in number of butterflies seen as temperature rises. The R^2 value of 0.0076 indicated little to no correlation between temperature and total number of butterflies seen – in other words, the variation in butterflies seen is not well explained by variation in temperature.

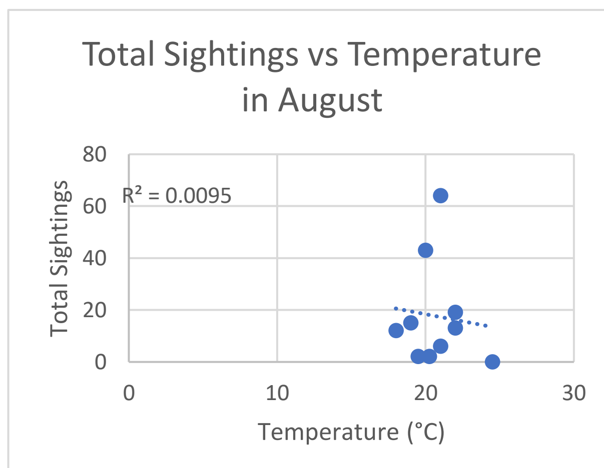
Considering the poor correlation between overall average temperature and total butterfly sightings, I broke down the summer into four months to examine if perhaps the time of year would also influence the butterflies sighted. From our project, it seems as if butterflies were more active in July and August, so perhaps temperature could still be a useful indicator of butterfly activity on a given day when considering overall activity of butterflies for just that time of summer. The results were as follows:





Figures 2-5. Breakdown of butterflies seen vs average temperature in each month. Each month showed little to no correlation between both variables except for July, which showed a moderate negative correlation between average temperature and butterflies seen.





Temperature continued to have little correlation with total butterfly sightings, except in July, where an increase in temperature appeared to be strongly negatively correlated with butterfly sightings. However, there were fewer samples done in July so it is possible that the limited sample size is biased and does not truly represent butterfly abundance as a function of temperature.

Overall, it appears there is no general correlation between temperature and butterfly sightings. Next, I explored the correlation between cloud cover and butterfly abundance. The results were as follows:

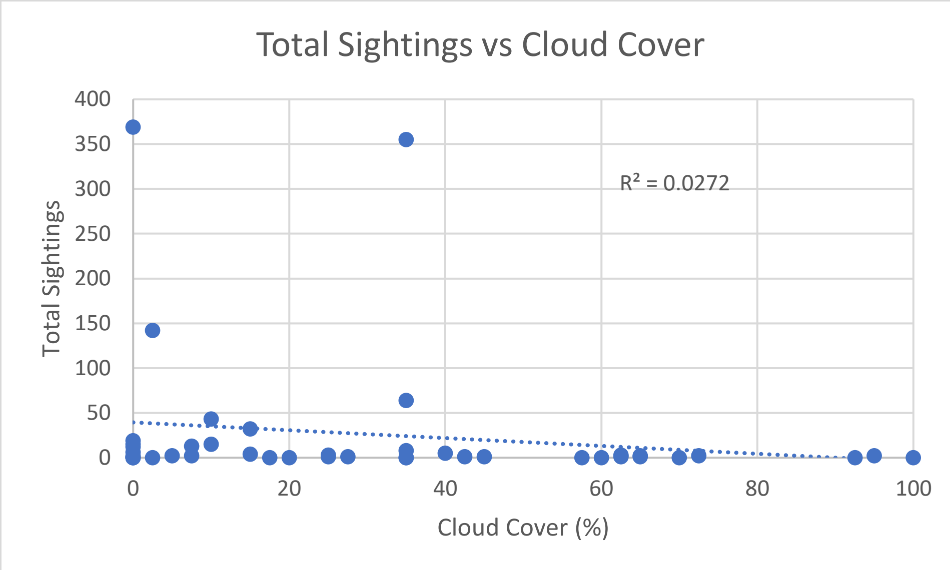


Figure 6. Total butterfly sightings expressed as a function of average cloud cover. The trendline shows a weak decrease in number of butterflies seen as cloud cover rises. The R^2 value of 0.0272 indicated little to no correlation between cloud and total number of butterflies seen. The variation in butterflies seen is not well explained by variation in cloud cover.

The correlation between cloud cover and total butterfly sightings is stronger than it was with temperature, but the correlation is very weak at best. Cloud cover, then, does not seem to be a good indicator of butterfly activity on a given day.

Finally, I examined wind speed and its relationship to total butterfly sightings. The results were as follows:

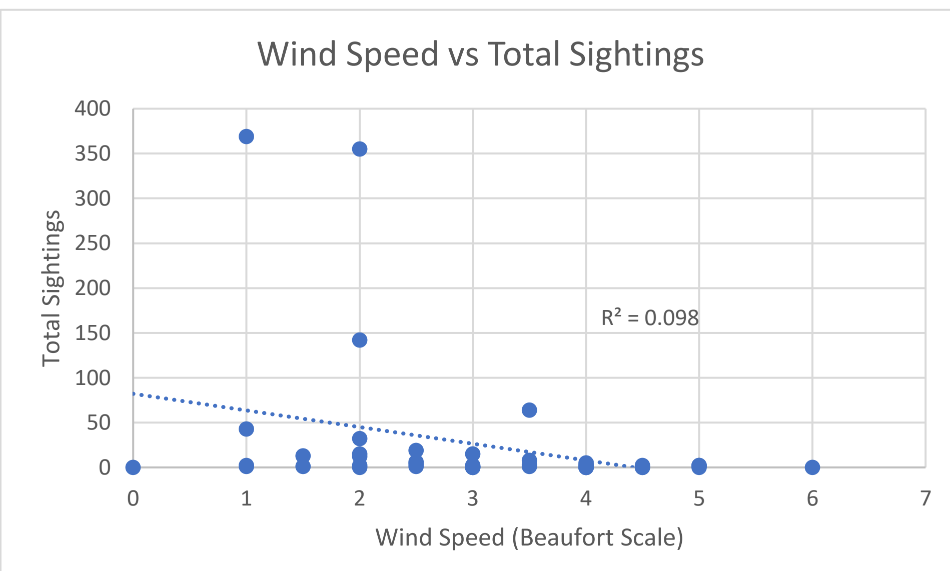


Figure 7. Total butterfly sightings expressed as a function of average wind speed. The trendline shows a weak decrease in number of butterflies seen as wind speed rises. The R^2 value of 0.098 indicated a weak correlation between wind speed and total number of butterflies seen. The variation in butterflies seen is not well explained by wind speed.

These results indicate that each environmental factor by itself is not a strong predictor of butterfly abundance. To try and examine these three key environmental factors and their effect on butterfly abundance in a different light, I split up butterflies by species, hoping to eliminate any confounding variables or bias introduced by lumping different species together. I took our most observed butterfly, the European Skipper (*Thymelicus lineola*), and examined the relationship between its abundance and the three environmental conditions. According to Acorn (1993), European Skippers are most common in late June and July, so I used the value from the first time a European Skipper was observed, July 14, and all subsequent data points, assuming that before the first observation the Skipper was not present in the Edmonton area. The results were as follows:

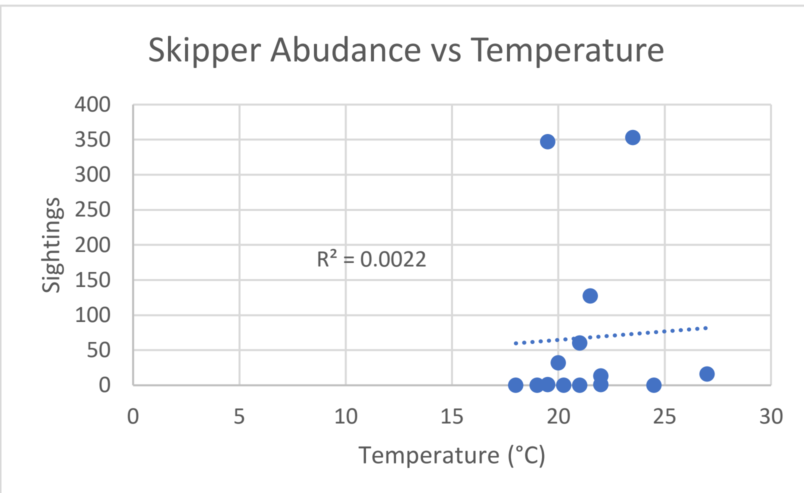


Figure 8. Skipper sightings expressed as a function of average temperature. The trendline shows a weak increase in the number of European Skippers sighted as the temperature increases. The R^2 value of 0.022 indicated no correlation between temperature and total number of European Skippers seen. The variation in Skippers seen is not explained by variation in temperature.

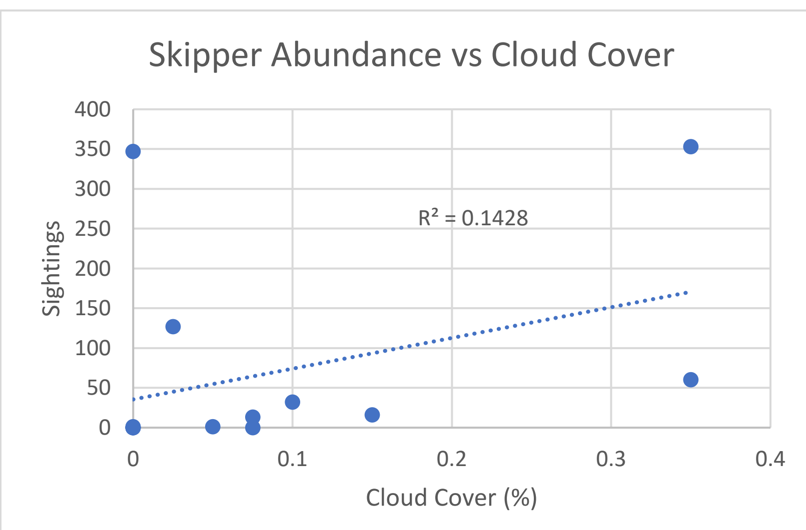


Figure 9. Skipper sightings expressed as a function of average cloud cover. The trendline shows a weak increase in the number of European Skippers sighted as the cloud cover increases. The R^2 value of 0.1428 indicated weak correlation between cloud cover and total number of European Skippers seen. The variation in Skippers seen is not well explained by cloud cover.

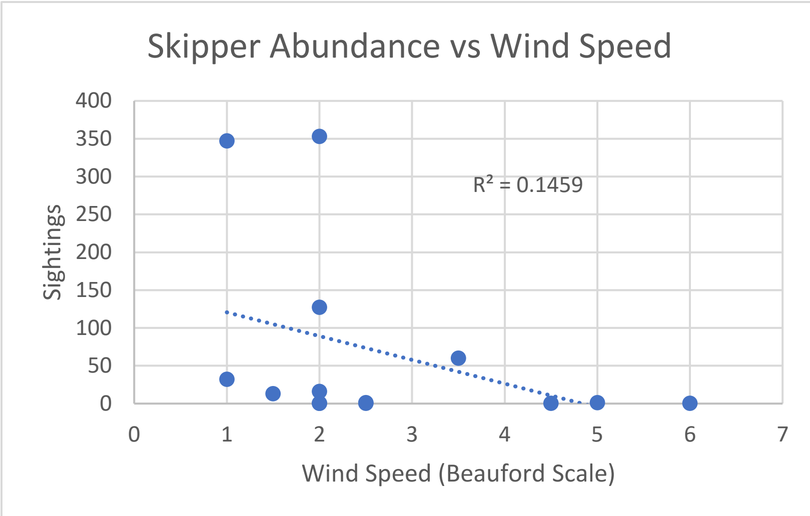


Figure 10. Skipper sightings expressed as a function of average wind speed. The trendline shows a weak decrease in the number of European Skippers sighted as the wind speed increases. The R^2 value of 0.1459 indicated weak correlation between wind speed and total number of European Skippers seen – in other words, the variation in Skippers seen is not well explained by wind speed.

Again, the data shows no strong correlation between an individual environmental condition and the abundance of butterflies on a particular day. There is weak correlation between wind speed and cloud cover, but not enough to suggest that these variables could be used to predict butterfly abundance. Finally, I focused only on the data from route A to see if eliminating other routes would give an indication of relative abundance of butterflies on a specific route. Some of our routes had little to no butterflies on them, so it is possible they were skewing the results toward zero. I examined only route A, our most productive and most used route. The results were as follows:

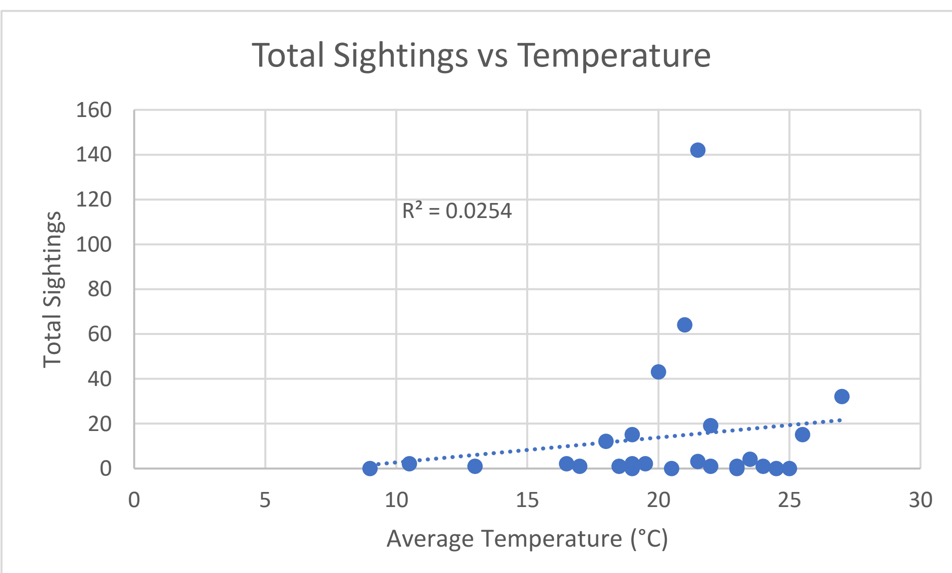


Figure 11. Total sightings expressed as a function of average temperature. The trendline shows a weak increase in the number of butterflies sighted as the temperature increases. The R^2 value of 0.0254 indicated little to no correlation between temperature and total number butterflies seen – in other words, the variation in total sightings seen is not explained by variation in temperature.

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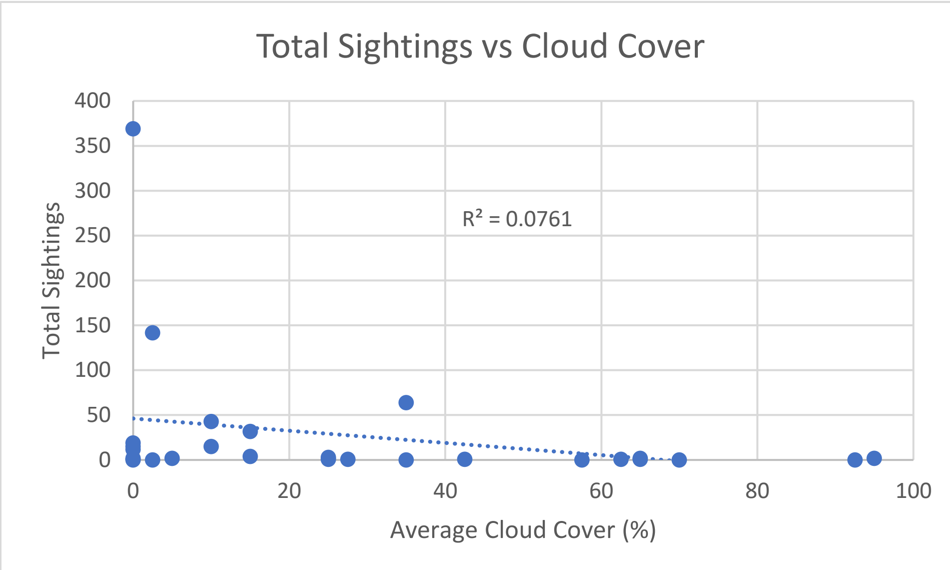


Figure 12. Total sightings expressed as a function of average cloud cover. The trendline shows a weak increase in the number of butterflies sighted as the cloud cover decreases. The R^2 value of 0.0761 indicated little to no correlation between cloud cover and total number butterflies seen; the variation in total sightings is not explained by the cloud cover.

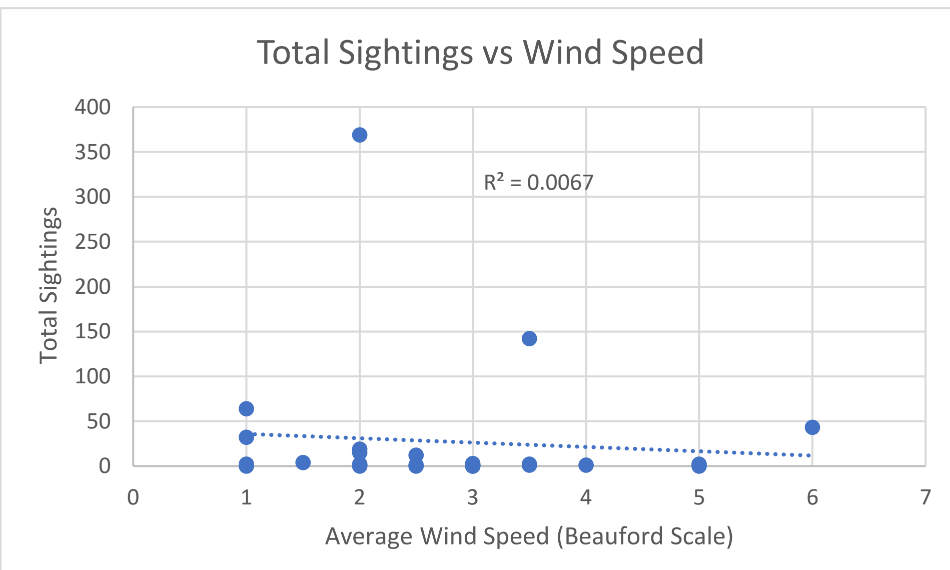


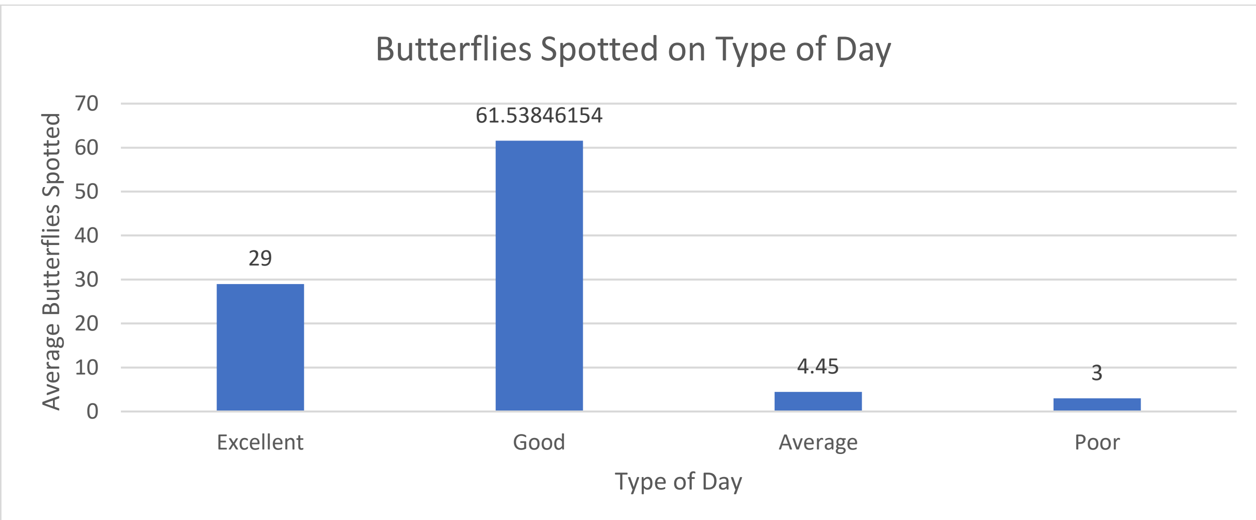
Figure 13. Total sightings expressed as a function of average wind speed. The trendline shows a weak increase in the number of butterflies sighted as the wind speed decreases. The R^2 value of 0.0067 indicated little to no correlation between wind speed and total number butterflies seen – in other words, the variation in total sightings seen is not explained by variation in wind speed.

Once again, there were no strong correlations between any variable by itself and the number of butterflies spotted, even when only one route was considered.

All three variables on their own appear to be poor predictors of butterfly abundance. However, these factors do not occur in isolation – on any given day, all three factors will be affecting butterflies in each area. To do examine whether butterfly abundance would be affected by the quality of the day in a way that considered all three variables, I split days into three categories, choosing cut offs based on the median value in the datasets. An "excellent" day was one that had good temperatures, good wind speeds, and good cloud cover. Good temperatures were above the median temperature value, while good cloud cover and wind speed values were below the median value. A good day fulfilled two of the three categories, an average day fulfilled one of the three categories, and a poor day fulfilled none of the categories.

Excellent Day	Temperature	Cloud Cover	Wind Speed
	≥ 20.5	≤ 25	≤ 3

When the results of this categorization were analyzed, the results produced were as follows:



If two of the three variables examined in this project are met, the average number of butterflies seen is substantially higher than if only one or none of the variables are met. Although there is not one key factor that can predict butterfly abundance based on these results, it appears that so long as two of the key factors – wind speed, temperature, or cloud cover – are above a satisfactory threshold, it is likely that butterfly abundance will be high on that day.

Discussion

Unfortunately, the data gathered in this experiment was not sufficient to indicate which environmental condition is the best for predicted butterfly abundance on a day. However, I could determine that if two of temperature, cloud cover, and wind speed are in acceptable ranges, the numbers of butterflies seen on a survey will be substantially higher. While this is not the information I hoped to learn from this study, it is still useful to know how combinations of factors may affect butterfly abundance – for example, it would probably not be worthwhile to do a survey on a day when the temperature is high, but there is significant cloud cover and wind, as the results of this study indicate that just one favourable variable is not enough to see significant numbers of butterflies.

The fact that none of the variables correlated strongly with butterfly abundance could mean several things. First, it could simply be that the natural variation in butterfly population that is controlled by biotic factors such as reproduction rate and hatching time is “drowned out” the day-to-day variance caused by changing environmental conditions. It’s possible that there were other environmental factors affecting butterfly abundance that weren’t considered in this project. Finally, it’s also possible that environmental factors simply aren’t key in predicting day to day butterfly abundance.

However, although there were no strong correlations between any of the variables, there were general patterns throughout the results. For example, a higher temperature almost always was related to a general increase of butterflies seen, except in the hot summer months when the temperature may have become too hot for butterfly activity. Even if the correlation in the datasets was not strong, this general increase in butterflies sighted in warmer weather was a pattern consistently observed through the analysis. It is possible that with a more rigorous experimental design that could eliminate some of the background noise that occurs with an observational experiment like this could find a strong correlation between butterflies sighted and temperature. Perhaps using the exact same route for every survey, only surveying on days with a similar wind speed and cloud cover, and/or surveying only one family or species of butterfly could yield more statistically significant results in this regard. Further research, perhaps down these suggested paths, is needed to determine if there is a key environmental factor in determining butterfly abundance.

Acknowledgements

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