The Effect of Temperature on Northwest Crow Flocking Behaviour

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ABSTRACT

The flocking behaviour of northwest crows (*Corvus caurinus*) is an important mechanism for crows to protect themselves from predators and to keep warm (Goodenough et al, 2017). The objective of this study is to determine whether temperature affects the flocking behaviour, i.e., size of crow flocks and number of flocks, of northwest crows in Vancouver, BC, as winter approaches. It is hypothesized that as temperature decreases, crows will flock in larger flocks. To perform this experiment, the number of crow flocks as well as the approximate size of the flocks (grouped into categories to approximate the number of crows per flock: 2-5, 6-20, 21-50, 51-100, >100) was tallied for a ten-minute period prior to sunset daily for 2 weeks (n=14) in the same location. The temperature at the time of data collection was recorded. A linear regression was performed on the number of crow flocks and temperature to determine whether there is a correlation. It was determined that there is a negative correlation between total number of flocks and temperature as the beta-coefficient is -0.79 and with a statistically significant p-value of 0.0073 (<0.05). Separate linear regressions were performed for individual categories of the sizes of the flocks which found that only flocks with less than five crows had statistically significant correlations with temperature. Therefore, the study fails to reject the null hypothesis that temperature has no effect on crow flocking behaviour and thus concludes that temperature does not impact northwest crow flocking behaviour.

INTRODUCTION

Throughout fall and winter, thousands of northwest crows (*Corvus caurinus*) commute 30-40 minutes from all over Vancouver to their home base (roosting site) by Still Creek in Burnaby (Thuring, 2019). This flocking phenomenon is an impressive sight that occurs twice daily, as crows travel to urban areas during the morning to forage for food, and travel back to their roosting site at Still Creek where they congregate at night. This flocking behaviour prevalent in birds is important as it helps protect them from predators, and keeps them warm (Goodenough et al., 2017).

A study conducted on Peruvian thick-knee birds found that large flocks of birds exposed to hotter temperatures would split up into smaller groups, thus forming more flocks overall (Comacho 2012). Similarly, another study conducted in Oklahoma found that overall flock sizes of American crows (*Corvus brachyrhynchos*) increased from June to September, as temperature decreased (F. Knopf & B. Knopf, 1983). In another study conducted by Mangini and Areta (2018) that tested a hypothesis known as the foraging hypothesis: where if birds fly in flocks, they increase their foraging efficiency and can spend more time feeding and less time looking out for predators, they found that various bird species in mixed flocks presented higher flocking propensity in colder seasons compared to in warmer seasons.

While this research already exists on the overall flocking behaviour of crows and other birds throughout the days, there is a lack of research specific to the flocking behaviour of northwest crows in relation to temperature, specifically leading up to winter. Therefore, the objective of this study is to determine if there are any changes in crow flocking behaviour (i.e., flock sizes, and number of flocks) as winter approaches and temperature decreases. It is hypothesized that if flocking behaviour is impacted by temperature, then more crows will flock together during colder temperatures than in warmer temperatures, and there would be less flocks of crows overall.

METHODS

We observed the flocking behaviour of crows flying at sunset once daily for 2 weeks from the roof of a building to see if there are any changes in flock sizes and number of flocks as winter approaches and temperature decreases. We chose to collect data ten minutes prior to sunset for ten minutes as we determined that it was the time which the majority of crows passed by the area of data collection. Ten minutes before sunset, using a phone camera to take videos, as well as a slow-motion app for accuracy, we recorded the number of groups of crows and the size of the crow flocks. We tallied the data in a table containing categories of groups by approximate size to approximate the number of crows in each flock. The crow flock sizes which were collected for this study organized the data into bins of: 2-5, 6-20, 21-50, 51-100, >100 crows per flock. In this study, flocks with less than 5 crows were referred to as small flocks, flocks with 6-20 and 21-50 crows were referred to as medium flocks, and flocks with more than 50 crows were referred to as large flocks. We did not consider lone crows in this study as the focus of this study is on flocking behaviour.

In addition, we recorded the temperature at the time of data collection. We also noted additional weather information such as rain, cloudy skies, or heavy winds. The location of data collection was maintained constant throughout the study and only crows from the same route were considered, as shown in Figure 1 below.

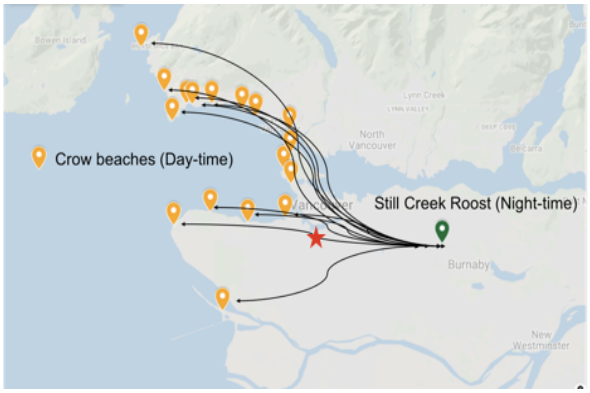

Figure 1: The many routes that crows take to get to and from their roosting site. The star represents where the data was collected. Image adapted from Thurling, 2019.

Using the statistical analysis program Prism, we created a linear regression model to determine whether there is a correlation between temperature and number of flocks per day at the time of data collection. In addition, we performed individual linear regressions and p-value analyses for each of the categories of sizes of flocks to determine if there is a statistically significant correlation between the individual categories and temperature. The slope of the linear regression curve (or, the beta-coefficient) would suggest whether there is a positive correlation, negative correlation, or no correlation between the two variables. In this analysis, temperature was the predictor variable and total number of flocks/number of flocks per category was the response variable. To determine how well the model would fit the data, we calculated the R^2 goodness-of-fit value, which further helped determine whether the variables were correlated. We also calculated the p-value for the slope to confirm if the findings were statistically significant to determine if we can reject or fail to reject the null hypothesis that there is no correlation between flocking behaviour and temperature.

RESULTS

Data was collected for 14 days (n=14). The total number of flocks per day at the time of data collection ranged from 27-36, with an average of 30 flocks per day. As seen in Figure 2, there were significantly more small flocks than larger flocks. These small flocks (2-5 crows) had more variation compared to the other size categories, as represented with the large error bars in Figure 2. During data collection, it was observed that several crows fly in smaller flocks near the end and beginning of the ten-minute period, prior to and following the large and medium flocks.

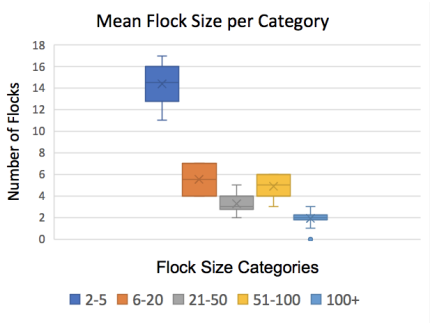

Figure 2: Mean flock sizes per size category.

In Figure 3 this linear regression graph was obtained by plotting temperature, against the total number of flocks, then generating the best fit line which results in a simple equation: $y=\alpha+\beta x$, where α is the y-intercept, and β is the slope of the line. This resulted in the equation $y=35.34-0.7973x$ best representing the observed data. The slope of the linear regression graph, the β-coefficient, is -0.7974, indicating a negative correlation between temperature and flock size. The p-value for the slope is 0.0073, which is less than an alpha of 0.05. The 95% confidence intervals are -1.336 to -0.2586. The R^2 goodness-of-fit value is 0.4643.

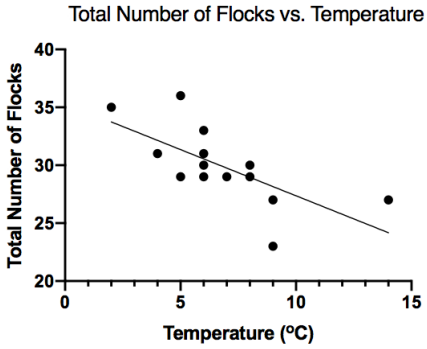

Figure 3: Linear regression of total number of flocks vs. temperature

Individual linear regressions were performed on each of the categories of sizes of flocks to determine whether each individual category of sizes had a correlation with temperature. As seen in Table 1, only the category for flocks with less than 5 crows had a p-value that is less than 0.05, and all categories other than the >100 crows category had weak negative correlations.

Size of flocks:	2-5	6-20	21-50	51-100	>100
β-coefficient	-0.1102	-0.1102	-0.097	-0.1574	0.08397
p-value	0.0362	0.3791	0.3379	0.1208	0.7201

Table 1: Linear Regression Results for the Individual Categories of Sizes of Flocks

DISCUSSION

Interpretation of the Results

Based on the results of the linear regression analysis, we fail to reject the null hypothesis that temperature has no effect on crow flocking behaviour and have insufficient evidence to support the alternative hypothesis. When only considering the data from the linear regression performed on the total number of flocks, there is some statistically significant evidence to suggest that crow flocking behaviour is negatively correlated with temperature based on the small p-value of 0.0073 for the slope of the as the p-value is less than an alpha of 0.05, however, the individual linear regressions only show statistically significant results for the small flocks with less than 5 crows. The p-values for the 6-20, 21-50, 51-100, and 100+ categories were all greater than an alpha of 0.05, meaning the correlations observed are not statistically significant for these groups. Therefore, based on the results obtained, temperature has no statistically significant effect on the size and number of crow flocks. This can be attributed to several factors such as small sample size (n=14), or limitations in the experimental design that could have introduced error. As a result, more data is needed to gain more conclusive results to potentially reject the null hypothesis.

Errors & Uncertainty in the Experimental Design

Data was gathered for 10 minutes each day which was determined to be the approximate time it took before sunset for most crows to have passed through the location of data collection. The time which sunset occurred was determined through the Weather Network website, and there is no readily available data which confirms the exact time which all of the crows commute to Still Creek. This may have impacted the results as each minute is valuable in this study. It is for this reason that several of the data points had to be excluded from the analysis as being one minute late to recording the data could greatly impact the results. The methodology used in this study differed greatly from the methodology used in the study conducted in Oklahoma, where they viewed the flocking behaviour of American crows as temperature changed throughout the day (F. Knopf & B. Knopf, 1983). This difference in methodology

could have resulted in different results due to the time-dependent nature of the experimental design present in this study where data was collected during sunset, as opposed to the less time-dependent experimental design where data was gathered all day. In addition, data was collected from one location which is not representative for the whole population in the area, as shown in Figure 1 above, as opposed to other studies which conducted the experiment in varying locations.

As we were visually determining what was considered one flock or more, that may introduce error in this study as there was only one data collector in this experiment. In addition, two flocks flying close together were differentiated only if there was a visible space between the two flocks on the slow-motion video, which was determined by the one data collector. Crow flocks that were flying over each other in the vertical were considered to be part of the same flock in this study which could also introduce error.

Throughout the days of measurement, the temperatures did not vary significantly. Most of the data was collected on days where the temperature was in the 6-8^{o}C range, with only one of the days getting to a high of 14^{o}C and another day with a low of 2^{o}C. Had the study been performed with a larger time frame and more variable timeframes, for instance an entire year, more conclusive data may have been obtained regarding the relationship between temperature and crow flocking behaviour. In addition, other confounding variables such as precipitation may have impacted the results as three of the data points were collected on days which had light or moderate rainfall. This may affect the results both by adding an additional variable and by affecting the ability to observe other variables. On one of the days where there was moderate rainfall, the visibility was reduced, making it a bit more difficult to view the flocks, and as a result may have impacted the results as well.

Similar Studies

The results gathered from this experiment refutes the studies conducted by Camecho (2012) and F. Knopf & B. Knopf (1983), which viewed the impacts of temperature on flocking behaviour of different bird species and concluded that temperature is a contributing factor. Similar to our hypothesis, they found that as temperature decreases, flock sizes increase. Our results are different which may be due to the potential limitations in experimental design stated above, as well as the small sample size.

Looking Ahead

In the future, if this study were to be done again, additional measures would be implemented to reduce uncertainty and improve the methodology. This includes measures such as accounting for confounding variables such as rainfall, reducing chance of error by getting more researchers to participate in this study as data collectors, increasing the timeframe of the study to account for greater temperature variability, and recording data from different locations in the Lower Mainland to better extrapolate the results to the general population of crows in Vancouver. A potential future study would be to observe the effects of the amount of rain precipitation on flocking behaviour, given that Vancouver, BC experiences lots of rainfall during the winter.

CONCLUSION

In conclusion, there is insufficient evidence to suggest that crow flocking behaviour is impacted by temperature, and we fail to reject the null hypothesis that temperature has no effect on flock sizes and number of flocks. This goes against our initial hypothesis that as temperature decreases, crows would flock in larger groups, and there would be more groups overall, similar to what the literature suggests. More research should be done with a larger sample size to gain more conclusive data that would potentially support this hypothesis.

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CITATIONS AND LITERATURE CITED

Camacho, Carlos. “Variations in Flocking Behaviour from Core to Peripheral Regions of a Bird Species’ Distribution Range.” *Acta Ethologica*, vol. 15, no. 1, 2011, pp. 153–158., doi:10.1007/s10211-011-0111-z.

Fritz L. Knopf, and Barbara A. Knopf “Flocking Pattern of Foraging American Crows in Oklahoma” *The Wilson Bulletin,* vol. 95, No. 1, 1983, pp. 153-155

Goodenough, Anne E., et al. “Birds of a Feather Flock Together: Insights into Starling Murmuration Behaviour Revealed Using Citizen Science.” *Plos One*, vol. 12, no. 6, 2017, doi:10.1371/journal.pone.0179277.

Inc., Pelmorex Weather Networks. “Vancouver, BC Weather.” *The Weather Network*, www.theweathernetwork.com/ca/weather/british-columbia/vancouver?wx_auto_reload=.

Mangini, G. Giselle, and Juan Ignacio Areta. “Bird Mixed-Species Flock Formation Is Driven by Low Temperatures between and within Seasons in a Subtropical Andean-Foothill Forest.” *Biotropica*, vol. 50, no. 5, 2018, pp. 816–825., doi:10.1111/btp.12551.

Thuring, Christine, et al. “Crows of Vancouver: The Middle Way Between Biophobia and Biophilia.” *The Nature of Cities*, 27 Apr. 2019, www.thenatureofcities.com/2019/04/26/crows-vancouver-middle-way-biophobia-biophilia/.

APPENDIX

*Rain

Date	Temperature (°C)	Total # of Flocks
October 31st, 2020	6	29
November 1st, 2020	4	31
November 2nd, 2020	9	23
November 4th, 2020	14	27
November 6th, 2020	9	27
November 8th, 2020	2	35
November 11th, 2020	5	36
November 12th, 2020*	5	29
November 16th, 2020*	6	30
November 20th, 2020	8	29
November 21st, 2020	6	31
November 22nd, 2020	6	33
November 24th, 2020*	8	30
November 26th, 2020	7	29

Size of Flocks

	2-5	6-20	21-50	51-100	100+
October 31st, 2020	14	5	3	6	1
November 1st, 2020	17	4	3	5	2
November 2nd, 2020	12	5	2	4	0
November 4th, 2020	14	4	2	5	2
November 6th, 2020	11	6	4	3	3
November 8th, 2020	16	7	4	6	2
November 11th, 2020	17	7	3	6	3
November 12th, 2020	15	4	2	6	2
November 16th, 2020	16	4	5	4	1
November 20th, 2020	13	6	3	5	2
November 21st, 2020	15	7	3	4	2
November 22nd, 2020	16	5	3	6	3
November 24th, 2020	14	6	4	4	2
November 26th, 2020	11	7	5	4	2