EFFECT OF PERCIPITATION ON TREE SWALLOW NEST PRODUCTIVITY AT BEAVERHILL LAKE, ALBERTA

By TESSA FRISKY

Intern

For Beaverhill Bird Observatory

December 2022

INTRODUCTION

Tree swallows (*Tachycineta bicolor*) are aerial insectivores that prey on insects within the order Diptera, and it is thought that the majority of their diet is made up of invertebrates of aquatic origins. However during their early stages of life, they are known to consume terrestrial insects as well (Mengelkoch, et. al, 2004). Transition ecosystems between grassland and wetland habitats provide increased abundance of aquatic-based invertebrates due to the presence of water nearby which is necessary for invertebrate eggs and larvae to grow (Mengelkoch, et. al, 2004). This invertebrate abundance can heavily impact the breeding success of tree swallows through increasing an individual's ability to provide enough nutrients to fuel the energy they are expending while foraging and undergoing natural life processes (Mengelkoch, et. al, 2004). It has been observed that higher rates of precipitation during the crucial first weeks of the mating and nest preparation season of tree swallows have a positive impact on the amount of eggs laid due to a larger presence of food availability to supplement their breeding behaviors (Dunn and Winkler, 1999).

Tree swallows are a migratory species that utilizes the Beaverhill Natural Area as a breeding ground annually.

In this paper I will hypothesize that high average monthly precipitation rates would result in a high average clutch size of tree swallow eggs due to an increased density of insects in the air column, therefore positively influencing the parents' ability to lay a larger amount of eggs. I predict that the high rates of precipitation in the first half of the summer season would have a strong visible relationship with the production of larger clutch sizes and overall encourage successful fledging.

METHODS

A long-term analysis was conducted over a 10 year period, from the years 2013 to 2022, to establish the relationship between precipitation and clutch size within the Beaverhill Natural Area, near Tofield, Alberta. Field surveys included checking nest boxes weekly by two interns, along three different grids; "New," "Road," and "Spiral" grids. The New Grid (New Grid)

possesses 50 tree swallow nesting boxes in a wet grassland located on the historical southern shorelines of Beaverhill Lake. The Road Grid (Road Grid) contains 66 nest boxes that are mounted on barbed wire fencing along Township Road 510 that is surrounded by farmland. The Spiral Grid (Spirel Grid) has 90 nest boxes in dry grassland that borders the historical shores of Beaverhill Lake and a densely forested area to the south.

Observations detailing the species' nesting state during the weekly surveys were written as active (A) if the box was being utilized for nesting, or inactive if it was empty, or abandoned. The progress of the nest's building phase (B) was noted in varying degrees of completion. The letter "p" states that the nest was partially built, appearing to have some structure with mostly dried grass material present. If the nest had a concave shape made up of only grass it would be deemed "f," for full. Lastly, if the building phase had reached its conclusion by containing feathers for insulation, it would be noted with an "i". Egg numbers and temperature were measured for each box by feeling whether they were warm (W) or cold (C) to determine if the tree swallow parents were incubating the eggs. Once hatched, nestling numbers and age were determined using a tree swallow aging guide (Early Tree Swallow Nestling Growth and Development). Comments for nesting box repairs and unusual findings were noted in the data for further context to the research.

The historical weather data provided via the Shonts AGCM weather station through the Alberta Climate Information Service gave insight into the total precipitation of each month in the beginning of the summer season (May and June) in millimeters to illustrate the weather patterns in the township area surrounding the Beaverhill Natural Area (Government of Alberta, n.d.). May and June were selected seeing as these months are when tree swallow breeding season is undergone and eggs are laid (Imlay et. al, 2018). I used this historical weather data to exemplify the observable relationship between total monthly precipitation and average clutch size of tree swallows.

Data analysis was conducted through Microsoft Excel software. Average clutch size was calculated by adding all egg numbers per year for each grid and dividing them by however many occupied boxes there were in the aforementioned grid. Some years within this study period are missing data from different grids, and therefore are omitted from the results and discussion analysis. New Grid was missing data from the years 2013, 2015, 2016 and 2018, Road Grid did not have data available for the years 2013, 2014 and 2015, and Spirel Grid was lacking data from 2015 and 2018.

RESULTS

During the month of May when tree swallows arrived in Tofield to begin making their nests, the total monthly precipitation was usually lower than June with the exception of the years 2014, 2016, 2020, and 2021 where there was significant rainfall from June rivaling those seen in May (*Figure 1.*). Years with the highest rainfall in May include 2016 with 114.65mm of precipitation, 2020 with 93.58mm, and 2021, which had 80.48mm. The lowest total precipitation seen in May belonged to the years 2015 (14.81mm), 2019 (14.31mm) and 2022 (12.70mm) (Table 1, *Figure 1.*). The years with the highest total precipitation in June include 2013

(76.62mm), 2017 (73.63mm), and 2022 (115.37mm). The lowest rainfall levels in June was from the year 2015 when there was only 32.20mm of precipitation. (Tabel 1, *Figure 1.*).

Table 1. May and June pecipitation and cl;utchsizes in three nest box grids from 2013 to 2022.

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
May precipitation	22.8	35.9	14.8	114.7	33.8	16.3	14.3	93.6	80.5	12.7
June precipitation	76.6	78.2	32.2	101.3	73.6	47.3	108.8	89.4	32.8	115.4
May & June combined	99.4	114.1	47.0	215.9	107.4	63.6	123.1	183.0	113.3	128.1
Spiral grid mean clutch size	6.5	5.9		6.3	5.7		5.9	6.0	6.6	6.8
New grid mean clutch size		6.2			5.3		6.6	6.2	6.4	6.9
Road grid mean clutch size				5.6	5.9	5.4	5.5	5.6	6.7	5.7

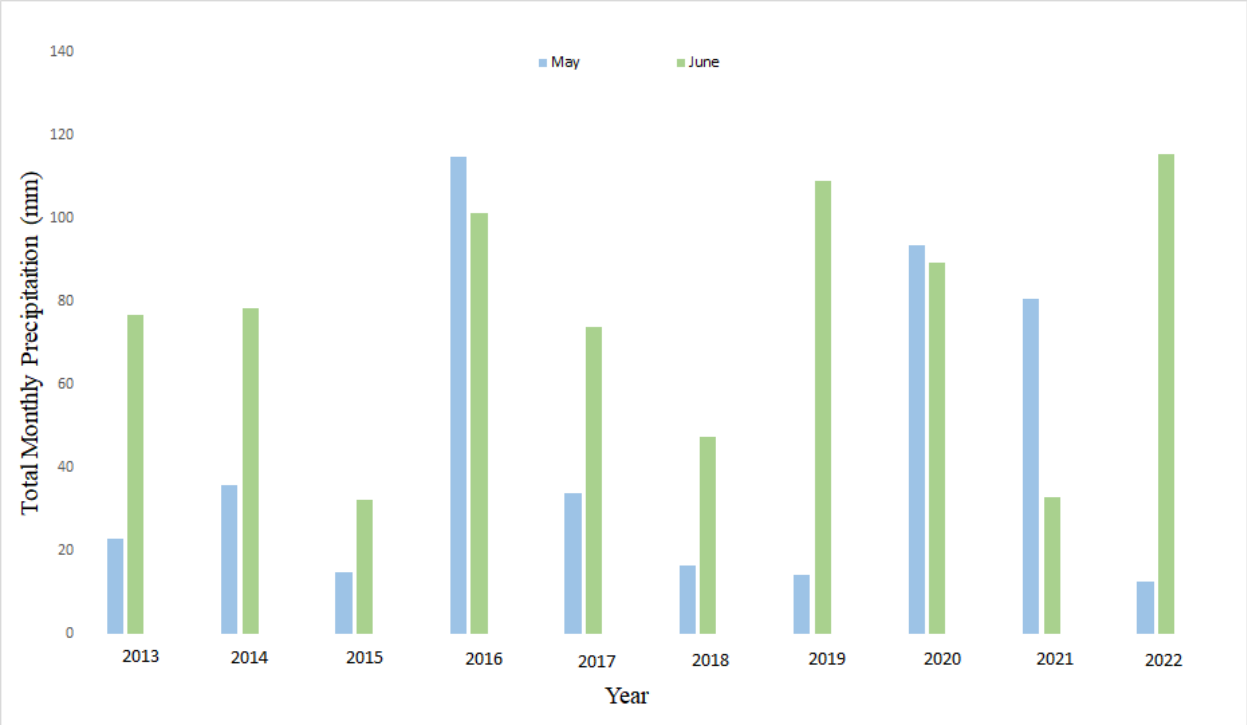

Figure 1. The total monthly precipitation (mm) for the months of May and June seen in Tofield, Alberta over a 10 year period collected by the Alberta government's historical weather database from the Shonts AGCM station (ACIS).

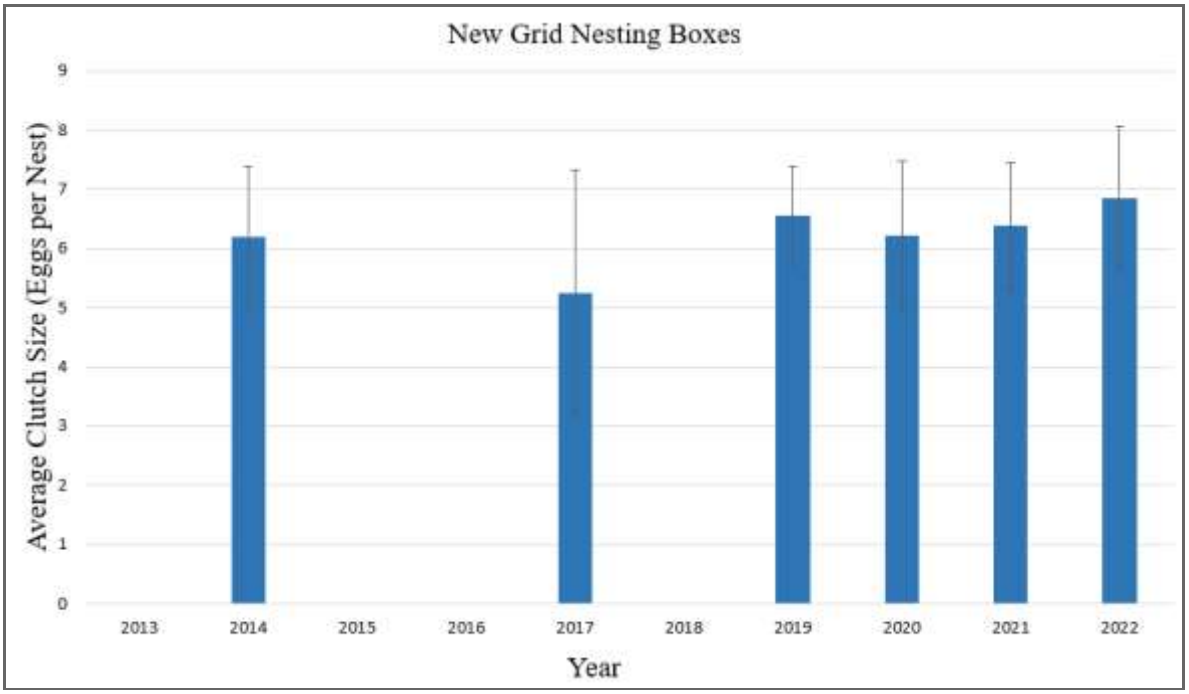

Figure 3. Average Tree Swallow clutch size in the New Grid from the year 2013 to 2022. The error bars were calculated using the standard deviation of the eggs recorded in the occupied nesting boxes.

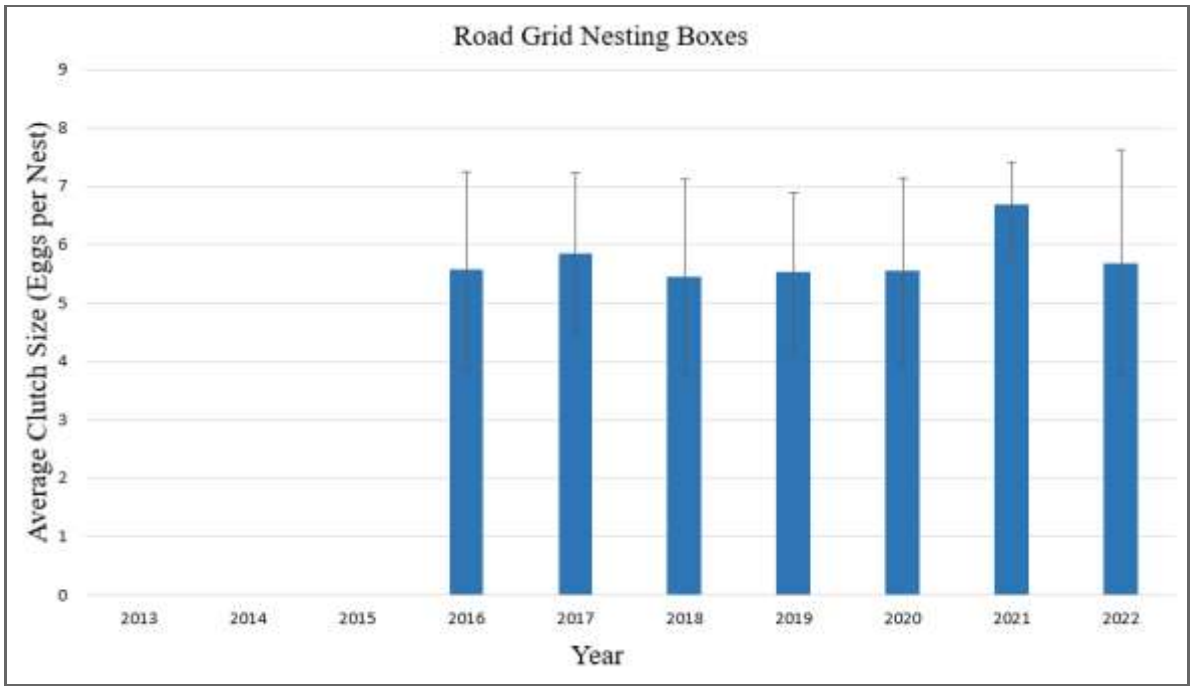

Figure 4. Average Tree Swallow clutch size in the Road Grid from the year 2013 to 2022. The error bars were calculated using the standard deviation of the eggs recorded in the occupied nesting boxes.

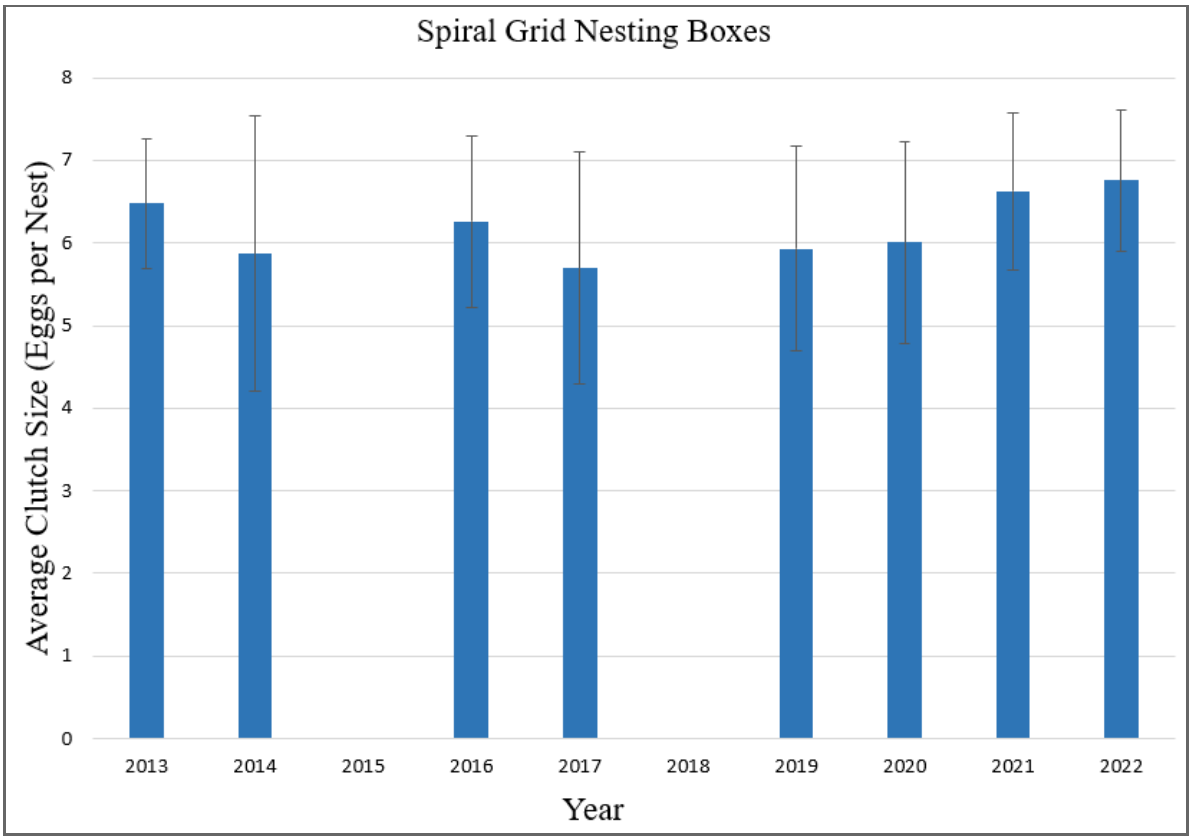

Figure 5. Average Tree Swallow clutch size in the Spirel Grid from the year 2013 to 2022. The error bars were calculated using the standard deviation of the eggs recorded in the occupied nesting boxes.

Typically tree swallows tend to have a clutch size of 4 to 7 eggs per nest (Audubon, 2022). In the New Grid, the highest average clutch size was that seen in 2022, with 6.85 eggs/nest, and the lowest of 5.26 eggs/nest in the year 2017, which was the lowest average clutch size between all grids. The clutch sizes for each year in New Grid were relatively high with the exception of 2017, most of them being in the range of low to high 6 decimal points (*Figure 3*).

Road Grid's highest average contained a clutch size of 6.68 eggs/nest in 2021, and had a low average of 5.45 eggs/nest in 2018. The Road Grid had the lowest averages overall in comparison to the other two grids, with clutch sizes being in the mid to high 5 decimal points, except for 2021 (*Figure 4*).

Within the Spirel Grid, the highest average clutch size was 6.76 eggs in 2022, and the lowest was 5.70 eggs in 2017. The Spirel Grid had the highest clutch size out of all three grids, and a consistently high annual average clutch size throughout the study period. Clutch sizes ranged from high decimals within the number 5 to high decimals of 6's (*Figure 5*).

Overall, low correlation coefficients indicated no support for the hypothesis that Tree Swallow clutch sizes were affected by month precipitation (Table 2). The correlation between the road

grid mean clutch size and June precipitation was -0.61 indicating that high rainfall could be related to smaller clutches, but at the New Weir grid for June the coefficient was +0.37, indicating the potentially opposite effect. The small sample sizes in the study make it impossible to reach a definitive conclusion. The average correlation coefficients are clost to zero indicating no effect.

Table 2. Correlation coefficients between clutch size in three grids and precipitation in May and June from 2013 to 2022

	May	June	May-June
Spiral grid mean clutch size	0.02	-0.08	-0.03
New-Weir grid mean clutch size	-0.16	0.37	0.21
Road grid mean clutch size	0.25	-0.61	-0.17
Mean correlation coefficients	0.04	-0.11	0.00

DISCUSSION

While moisture is considered generally better for tree swallows' food availability, it appears that increased rainfall during the early and midsummer months is preferable for maximizing the size of the clutch (Imlay, et. al, 2018). During the years with the lowest precipitation, the clutch sizes declined as seen with New Grid's lowest clutch averaging 5.26 eggs/nest during 2017, Road Grid having 5.45 eggs/nest during 2018, and Spirel Grid having 5.70 eggs/nest in 2017. The total precipitation of May and June in 2017 was 33.81mm and 73.63mm respectively, and in 2018 it was 16.27mm and 47.32mm. Years with May rainfall that was less than June also include 2013 (22.8mm in May), 2014 (35.91mm), 2015 (14.81mm), 2019 (14.31mm), and 2022 (12.7mm). These years resulted in relatively high clutch sizes, likely due to the increase in rainfall observed in June. The highest clutch sizes were in the years 2021 (Road Grid with 6.68 eggs/nest) and 2022 (New Grid with 6.85 eggs/nest, and Spirel Grid with 6.76 eggs/nest), which are both some of the highest total precipitation of the season for each year. The highest precipitation seen in 2021 was in May (80.48mm) and in 2022 was June (115.37mm). The years 2016, 2019, and 2020 also had high water levels, with the totals of May and June for each being 215.94mm, 123.14mm, and 182.95mm, resulting in moderate to high clutch sizes for each of the grids during those years. Although tese values seem to indicate an effect of precipitation on clutch size, the statistical comparison does not support such a conclusion.

The high precipitation rates likely provided the tree swallows with a greater abundance of their primary prey insects to feed on, which begin their lifecycle in a moisture rich environment (Mengelckoch et. al, 2004). This increase in food availability positively impacted the clutch sizes due to the adult's foraging needs being exceedingly met during the mating season so they were able to produce larger amounts of eggs (Imlay et. al, 2018).

CONCLUSION

It was previously hypothesized that high precipitation totals would result in a higher average clutch size for the tree swallows, and predicted that high monthly precipitation totals during the egg laying season would have a positive impact on the overall success of the young through the increased food availability for the adult tree swallows before and after laying. Long-term results show that the clutch sizes have varied slightly over the span of 10 years, and the rainfall has had a noticeably positive impact on the average clutch size of the tree swallows seeing as the years with high precipitation early on in the laying season (May and June) resulted in higher average clutch sizes. An increase in rainfall is likely to positively impact the availability of aerial insects that tree swallows prefer to forage on, providing them with more nutrients. High amounts of precipitation is seen to be beneficial to the tree swallows' overall ability to produce larger clutch sizes.

LITERATURE CITED

Dunn, P. O., & Winkler, D. W. (1999). Climate change has affected the breeding date of tree swallows throughout North America. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *266*(1437), 2487–2490. https://doi.org/10.1098/rspb.1999.0950

"Early Tree Swallow Nestling Growth and Development." *Treeswallows.com*, 20 Feb. 2022, https://treeswallows.com/tres/index.php/nestling-growth-and-development/.

Government of Alberta. (n.d.). *Interpolated Weather Data Since 1961 for Alberta Townships*. Retrieved September 3, 2022, from https://acis.alberta.ca/township-data-viewer.jsp

Imlay, T. L., Mills Flemming, J., Saldanha, S., Wheelwright, N. T., & Leonard, M. L. (2018). Breeding phenology and performance for four swallows over 57 years: Relationships with temperature and precipitation. *Ecosphere*, *9*(4). https://doi.org/10.1002/ecs2.2166

Mengelkoch, J. M., Niemi, G. J., & Regal, R. R. (2004). Diet of the nestling tree swallow. *The Condor*, *106*(2), 423–429. https://doi.org/10.1093/condor/106.2.423

Tree Swallow. Audubon. (2022, May 6). Retrieved September 4, 2022, from https://www.audubon.org/field-guide/bird/tree-swallow