
EFFECT OF TEMPERATURE ON THE REPRODUCTIVE ACTIVITY AND MATING CALLS OF SPRING PEEPERS, *PSEUDACRIS CRUCIFER*

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ABSTRACT

Spring peeper frogs (*Pseudacris crucifer*) become active in Pennsylvania come the middle of March when temperatures begin to rise, and they are able to come out of hibernation. It is not long after they emerge from their hibernation that their mating season begins, and their characteristic high-pitched characteristic peeping call can be heard, often considered one of the first signs of spring. Their calls are used by male peeper frogs to attract a female to reproduce with and the louder and more frequently the male frog is able to call, the better his chances are of successfully reproducing. This study used the decibels of male spring peeper calls as a proxy for successful reproductive activity in relation to nightly low temperatures, daily high temperatures, and the temperature at the time of data collection. Data was collected for a week from April 20th, 2020 until April 26th, 2020 in the evenings from a single pond. The recorded decibels were compared to the corresponding temperature data collected using scatter plots and a linear trendline was fitted to each plot. None of the plots proved to have significant data which could be because the data set was not large enough, the data collected was skewed by additional variable noises such as roosting birds and wind, outside addition factors like rainfall were not considered. The best correlation was seen between the nightly low temperatures and the calls. Repeated studies with larger data sets must be done to make any significant claims about the relationship of spring peeper calling and temperature.

Keywords: mating calls, reproductive activity, spring peepers (Pseudacris crucifer), temperature

INTRODUCTION

Throughout the winter *Pseudacris crucifer*, the spring peeper, hibernates on the forest floor under debris or inside cracked logs, and due to an increased production of glycerol, they are able to survive temperatures for down to -8 °C (Lane, 1995). Come March in central Pennsylvania the warmer rains of spring begin arriving and the frogs begin to come out of their hibernation. The male spring peepers begin to emit their characteristic high-pitched call by mid-March as one of the earliest indicators of spring.

These frogs are small tree frogs and prefer to live on the forest floor during most of the year, but during their breeding season from mid-March into early June, these frogs spend their time near vernal pools, ponds, or wetlands where fish are not present (Spring Peeper, n.d.). It is at these spring habitats that the male frogs gather in trios while beginning their calling in an effort to attract a female frog for them to fertilize the eggs of (Spring Peeper, n.d.). Typically, the louder the male frog is able to call the more likely he will be in attracting a female. Males frogs that call louder or higher-rate calls have been shown to be

larger, older, and in better body condition than frogs with lower-rate calls, and these frogs with the loudest calls have been shown to have the most reproductive success (Zimmitti, 1999).

The strength of the calls is associated with the reproductive activity of these frogs, so it may be possible to use the strength of the calls as a proxy for reproductive activity and success. Louder cumulative calling would be indicative of greater reproductive success and activity within a breeding area and quieter calling would be indicative of less reproductive success and activity. While it would be more accurate to measure reproductive activity by monitoring an area for eggs being deposited which indicate the frogs had successfully mated, the eggs in the initial survey for this study proved quite difficult to locate. The frog calls were heard in the evenings and tadpoles were found to be present in the vernal pond in question, but no eggs could be located among the heavy grassy underwater vegetation that may have provided the frogs with very effective camouflage. Therefore, the frog calls were decided to be used as a proxy for reproductive activity. It is thought that the frog's reproductive activity would be limited by temperature as they are cold blooded animals. My prediction is that the frogs will have quieter calling with lower nighttime low temperatures, daytime high temperatures, and temperatures at the time of data collection and vice versa for all warmer temperatures for all three categories. This study is being conducted in April during their peak time in their reproductive season when calling should be most prevalent.

FIELD SITE

This study took place at one site which is a vernal pond located in State College, PA. The vernal pond is approximately 1 mile away from the University Park Airport and is situated between open cornfields which had been harvested the previous summer and a thin line of pine forest which has a small walking path running through it which allows for easy human access to the pond. The pond substrate is comprised entirely of silt with some areas being bare silt and other being covered in submerged grassy vegetation. The pond is interspersed with areas of long grasses which stuck out of the water and take up open water space with the grass effectively splitting the vernal pond up into four main sections with many tiny pockets of water being dispersed throughout the area. Tadpoles were only discovered in the largest and deepest section of the

pond that had the most submerged vegetation of the four main water sections. There are often windy conditions in this area and birds have been found to nest in the strip of pine forest. A pair of mated mallard ducks were also spotted as frequent visitors to the pond. The vernal pond was seen to grow with rainfall and shrink a bit with less rain, but frequent rain during this study allowed for the main sections to be maintained. In the summer months this pond is known to decrease dramatically during drought or hot weather and in severe cases of drought it dries up completely.

METHODS AND MATERIALS

Initially the pond had been surveyed for submerged egg masses, but after that proved to be an unsuccessful strategy due to the effective camouflage of the eggs which resulted in no data able to be obtained the methodology was reevaluated and adapted to overcome the difficulty of being unable to locate the egg masses. The adapted methodology included measuring the calls of the frogs in decibels as their calls were being used as a proxy for measuring reproductive activity in lieu of being unable to actually count the eggs which would have been a more direct method. The phone app "Decibel X" was used to record the sound levels of the frog calls on an iPhone 11. The decibels for the frog calls were taken every day at 7:45pm as the sun was setting and the frogs began to wake up for their nightly calling in search of a mate. The app would take in the sound over time and give an average number of decibels, each recording was taken over the course of a minute. Care was taken to not record data during the take-off of planes from the airport located nearby as that was found to skew the decibels higher. Factors that were unable to be accounted for were the wind and precipitation that added to the noise level. It is thought that the birds nesting in the trees should not be a problem as the data was taken at the same time each day and their noise should in theory remain as a somewhat constant background noise with the relative changes in spring peeper calls being able to be discerned. The decibel data was collected from the same spot at the edge of the pond with the phone held out facing the pond while they app collected the sound data.

The temperature data was collected from the website weather.gov which measured the temperatures at the nearby University Park Airport 24 hours a day. Temperatures recorded were those at the

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time of collection, the nightly low temperature, and the daily high temperature for the day of collection.

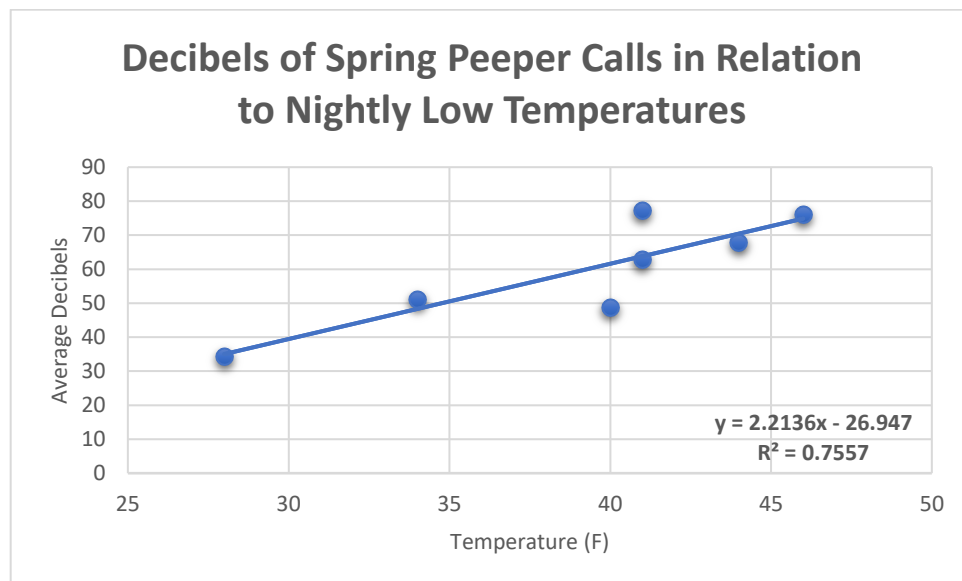
RESULTS

Data had been originally planned to be collected over the period of three weeks, but that was unable to be achieved and data was only able to be

collected for a period of one week at one pond which severely limited the scope of the data set. Ideal conditions would have allowed for observation over the course of several weeks to see the effects of a broader range of temperatures. Factors such as wind, precipitation, and roosting flocks of birds were unable to be accounted for in the decibel collection and may have compromised the integrity of the sound data.

Date	Nightly Low Temperature (°F)	Daily High Temperature (°F)	Temperature at Collection (°F)	Average Decibels
4/20/2020	41	59	54	77.2
4/21/2020	40	46	36	48.7
4/22/2020	28	48	46	34.4
4/23/2020	34	57	48	51.0
4/24/2020	44	54	52	67.8
4/25/2020	46	61	57	76.0
4/26/2020	41	43	39	62.8

Figure 1. This data table outlines the raw data collected for the temperatures and decibels on each particular date at 7:45pm over the course of one week in April.



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Figure 2. This graph highlights the relationship between the number of decibels collected on different dates and the nightly low temperatures that were recorded on those dates. A linear trendline was fitted to the scatter plot. The R^2 value indicates that the linear correlation is not significant ($P < 0.05$) when looking at x and y values.

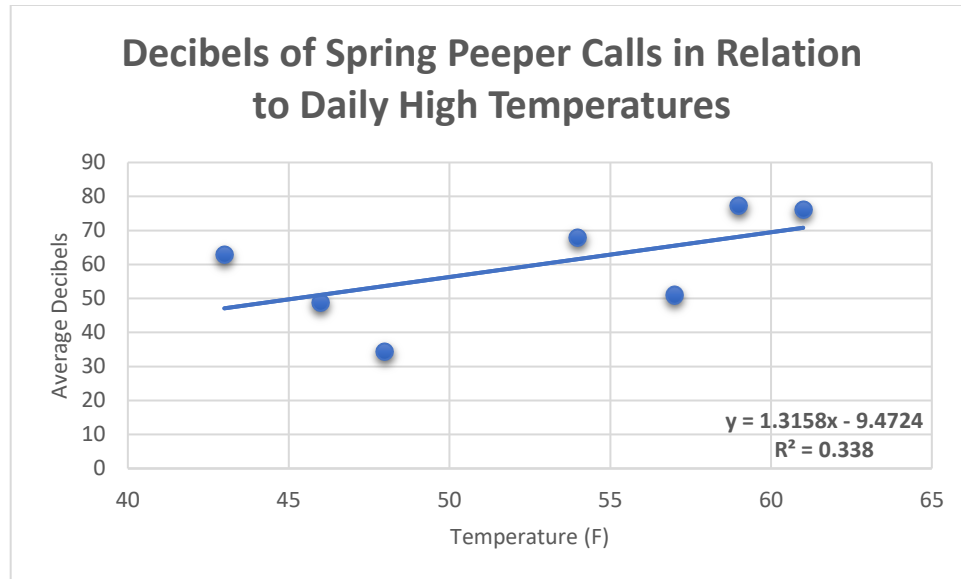


Figure 3. This graph highlights the relationship between the number of decibels collected on different dates and the daily high temperatures that were record on those dates. A linear trendline was fitted to the scatter plot. The R^2 value indicates that the linear correlation is not significant ($P < 0.05$) when looking at x and y values.

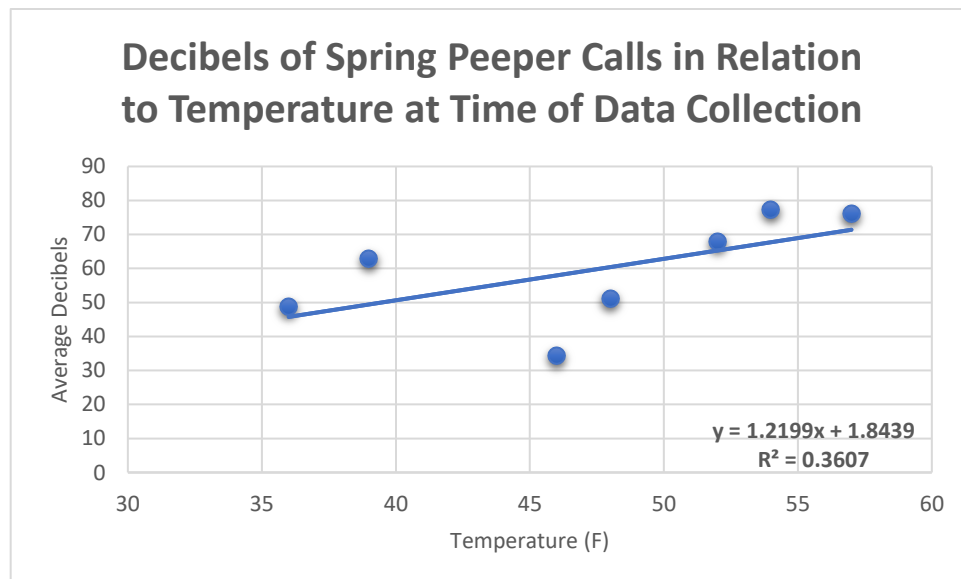


Figure 4. This graph highlights the relationship between the number of decibels collected on different dates and the temperatures at the time of collection that were record on those dates. A linear trendline was fitted to the scatter plot. The R^2 value indicates that the linear correlation is not significant ($P < 0.05$) when looking at x and y values.

The above data outlines three relationships between spring peeper calling and the temperature at collection, the daily high temperature, and the daily

low temperature. None of the results were found to be significant, however the best loose trend could be

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seen when comparing the nighttime temperatures to the decibels of frog calls.

DISCUSSION

The goal of this study was to study the relationship between the mating calls of the spring peeper frogs and the daily high temperatures, nightly low temperatures, and the temperatures at the time of collection to see if there was any direct correlation. Unfortunately, no significant correlations were able to be identified. This study would have benefitted from a larger data set to pull from with the data collection starting at the beginning of the mating season of the spring peepers starting in the middle of March and extending until their mating season ended in early June in order to track not only how their calling changes with temperature, but also over the course of their mating season. Taking data from multiple ponds over several mating seasons over the course of several years would have also contributed to increasing the integrity of the data set.

The data set collected in this study lacks volume and it also lacks integrity as it proved increasingly difficult to obtain sound data that was not tainted by the background noise that exists and varies day to day. Taking data at the same time each evening was intended to limit the variation in background noise coming from the birds to keep their noise at a constant, but this did not appear to be the case. Differing weather conditions also impacted the data collection as the field site was found to have daily variations in the wind speed which created different degrees of sound. Precipitation is also something that could have impacted the data as it seemed the frog were always louder after rainfall, but that was not the focus of this study.

No true conclusions can be made from this study as the data had no significant linear correlations were found and more studies must be done to fully comprehend the impact temperature has on the calling and reproductive activity of the spring peeper, *Pseudacris crucifer*.

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LITERATURE CITED

- Layne, J., and R. Lee. 1995. Adaptations of frogs to survive freezing. *Climate Research* 5:53–59.
- Spring Peeper. (n.d.). <https://www.nwf.org/Educational-Resources/Wildlife-Guide/Amphibians/Spring-Peeper>.
- Zimmitti, S. J. 1999. Individual Variation in Morphological, Physiological, and Biochemical Features Associated with Calling in Spring Peepers (*Pseudacris crucifer*). *Physiological and Biochemical Zoology* 72:666–676.