
FACTORS AFFECTING EASTERN SKUNK CABBAGE (*SYMPLOCARPUS FOETIDUS*) ABUNDANCE IN THREE CENTRAL PENNSYLVANIA SPRINGS

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ABSTRACT

This study investigated the distribution of Eastern Skunk Cabbage (*Symplocarpus foetidus*) across three different sites around Huntingdon, Pennsylvania, and the factors that affect its abundance. Through data collection at Cold Springs, Warm Springs, and Peace Chapel, we examined the relationship between Skunk Cabbage and various environmental factors. These factors included spring water pH, conductivity, and temperature. We examined twenty plots at each of the three sites, with ten on each side of the spring bank, and determined the total count of individual skunk cabbage in each plot. Our study found that conductivity and water temperature both had a positive correlation with skunk cabbage abundance, but pH did not have a significant impact on skunk cabbage abundance.

Keywords: *Symplocarpus foetidus*, *abundance*, *environmental factors*, *distribution*, *freshwater spring*

INTRODUCTION

Eastern Skunk Cabbage (*Symplocarpus foetidus*) is a flowering perennial plant that grows in wetlands and moist hill slopes in eastern North America. It can be found throughout eastern Canada and the northeastern United States, as far west as Minnesota and southwest to Tennessee and North Carolina. The plant blooms in early spring, from late February through May, depending on the region, which could include woodlands, wetlands, or near streams. It is known for its strong odor, which appropriately resembles skunk. This odor is a useful way for the plant to attract pollinators, as they can be drawn in by the scent of rotting meat (National Wildlife Federation). At the same time, the odor deters herbivore predators.

Skunk Cabbage has a unique characteristic among plants: it can produce its own heat. This ability is known as thermogenesis, or the ability to metabolically generate heat by utilizing cyanide-resistant cellular respiration (University of Wisconsin-Madison). This adaptation allows the plant to thrive in environments where other plants might struggle. Similarly, the Skunk Cabbage's deep root system

helps to provide stability in very damp areas where most other plants would be unable to survive. In turn, Skunk Cabbage is significant in the sense that its deep roots help with erosion and soil permeability. Its large, green leaves also provide good food for insects (Lake Forest College).

Studying Skunk Cabbage offers valuable insights into ecological processes, biodiversity, and ecosystem health. The early blooming period of the plant creates a crucial source of food for early-emerging pollinators, which are essential for plant reproduction and pollination. The Skunk Cabbages' unique adaptations to cold and wet environments make them an interesting subject for understanding plant resilience and adaptation.

Our primary research question driving this study is: what factors influence the abundance of Eastern Skunk Cabbage in different springs around central Pennsylvania? To answer this question, we identified various biotic and abiotic factors that could affect Skunk Cabbage distribution and growth. This study examines these factors, with a focus on their relationship with the presence and abundance of Skunk Cabbage. The three key sites, located in Huntingdon, Pennsylvania, included Cold Springs,

Warm Springs, and Peace Chapel. Each site offers different environmental conditions, providing a diverse background to explore the relationship between environmental factors and Skunk Cabbage Abundance.

FIELD SITE

For this study, we concentrated on three springs: Cold Springs, Warm Springs, and Peace Chapel, all located in Huntingdon, Pennsylvania. The Cold Springs site is located along a freshwater spring in a forested area off of Cold Springs Road. The water at this site has a pH of 6.50, indicating slightly acidic conditions, and a conductivity of 58.9 μS . To access this site, we first located the old schoolhouse and pulled into a driveway next to the path to the stream. This site is unique as it is the only one we visited that contains lesser celandine (*Ficaria verna*) in the water, alongside watercress (*Nasturtium officinale*), indicating nutrient-rich conditions. The surrounding forest consists of a mix of deciduous trees with moderate canopy cover, allowing some light to reach the forest floor. The spring itself is relatively narrow, with a bed of fine sand, pebbles, and cobbles, creating a gentle flow of water. The edges of the waterway are lined with leaf litter and small shrubs, contributing to the diversity of the site.

The Warm Springs site, also located off Cold Springs Road, is positioned along a freshwater spring at the edge of a forest, where the spring flows through a more open area. The water at this site has a pH of 6.71, indicating nearly neutral conditions, and a conductivity of 162.6 μS , suggesting a higher mineral content compared to Cold Springs. This site features an abundance of watercress, indicating a consistent water flow and sufficient sunlight. The surrounding vegetation included a mix of deciduous trees and shrubs, with relatively sparse canopy cover. The spring at Warm Springs is the widest among the study sites, and its bed is composed of sand and cobble, providing a stable substrate. This open setting allows for a wider variety of plants to grow along the edges, supporting a higher density of shrubs and undergrowth. The broader spring bed provided more space for Skunk Cabbage and other wetland plants to establish themselves.

The Peace Chapel site is situated along a freshwater stream deep within a forest. To access this location, we hiked along the Peace Chapel paved trail and then the loop trail. The stream runs through a transition zone where deciduous hardwoods meet coniferous habitats. The sampling area is in a valley near the intersection of these two habitats, offering a unique mix of forest types. The water at this site has a

pH of 6.83, indicating slightly alkaline conditions, and a conductivity of 75.6 μS . Unlike the other sites, the stream at Peace Chapel is narrower and has a faster flow, with a clay bed that provides a different substrate for plant growth. The stream's narrower width and higher speed limit the presence of aquatic plants, which contributes to its ecological characteristics. The head of the stream is not visible from our sampling location.

METHODS AND MATERIALS

To measure the environmental conditions at each site, we used portable meters to assess the conductivity and water pH of each location. Conductivity provides insight into the mineral content of the water, while pH indicates its acidity/alkalinity. These parameters help us understand the suitability of each site for Skunk Cabbage and the broader ecological conditions. These devices were calibrated shortly before each use to ensure accuracy.

To measure the abundance of Skunk Cabbage, we established a series of 5-ft by 5-ft grid sampling sections alongside both sides of the water at each site. We used a measuring tape to accomplish this grid. The sections were positioned to ensure a representative sample of the plant's distribution and allowed us to systematically count the number of individual Skunk Cabbage plants within each section. Using a total count technique, where every plant in the section is counted, we identified individuals by looking at the main stem. While each main stem had branching leaves or shoots, we still counted each main stem as an individual. This methodology provides a consistent approach to assessing Skunk Cabbage abundance across different field sites and helps to identify patterns or correlations with environmental factors. We collected data at Warm Spring and Peace Chapel on March 26, 2024, and collected data at Cold Spring on April 22, 2024.

RESULTS

Our study analyzed several key environmental parameters and Skunk Cabbage abundance at three field sites: Cold Spring, Warm Spring, and Peace Chapel. Warm Spring showed the highest total Skunk Cabbage count with 207 individuals, as well as the highest average Skunk Cabbage per plot. Cold Spring had the lowest total count at 92, while Peace Chapel fell in between at 97. The standard deviation was also calculated to measure the variability of Skunk Cabbage abundance across various plots.

Fig. 1 shows that Warm Spring had the highest sum and average skunk cabbage abundance, as well as the highest conductivity and water temperature.

	Cold Spring	Warm Spring	Peace Chapel
pH	6.50	6.71	6.83
Conductivity (uS)	58.9	162.6	75.6
Water Temp (C)	10.6	16.8	13.3
SPRING SUM	92	207	97
SPRING AVG	4.6	10.35	4.85
SPRING STDEV	4.476840991	4.392277913	3.344673692

Figure 1. Table of skunk cabbage abundance, conductivity, water temperature, and pH per site

Fig. 2 shows Warm Spring had the highest average of skunk cabbage per plot, and Cold Spring had the lowest. Peace Chapel had the lowest standard deviation of skunk cabbage per plot, and Cold Spring had the highest.

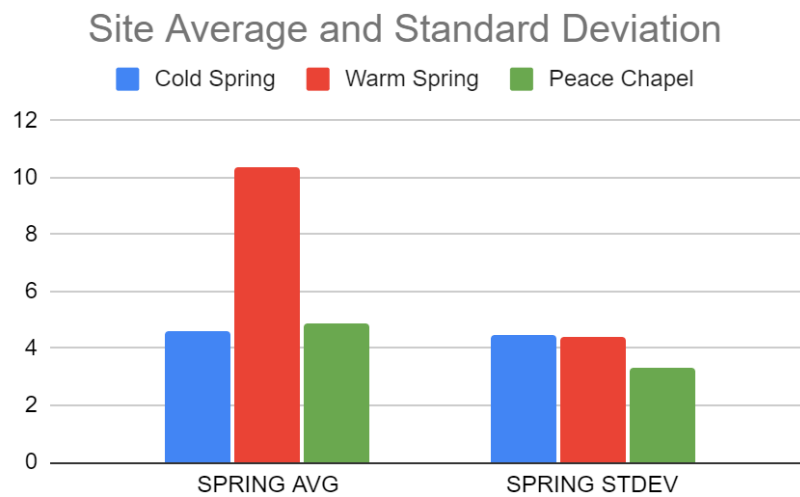


Figure 2. Average skunk cabbage abundance per plot at each site, with standard deviation indication variation in plot counts

Fig. 3, The Kruskal-Wallis Test, is a statistical test used to determine if there are significant differences between independent groups. This test is often used when the data does not meet the required assumptions for parametric tests. In our case, this test was used to analyze the counts of Skunk Cabbage at each plot and compare them across different sites. The Statistic (18.890) represents the Kruskal-Wallis statistic, which is the degree of variation between the groups. A high statistic value, which is present here, indicates greater differences between groups. The degrees of freedom (df=2) are determined by the

number of groups minus one. Since we have three sites, the degree of freedom is 2. The p-value indicates the probability that the observed differences between groups occurred by chance. A p-value that is less than 0.05 is usually considered statistically insignificant. In our case, the p-value is < 0.001, which indicates that the difference in Skunk Cabbage counts between the three sites is significant.

Kruskal-Wallis Test

DOI

Factor	Statistic	df	p
Spring	18.890	2	<0.001

Figure 3. Represents a Kruskal-Wallis Test for the skunk cabbage count for each plot split by spring. Because the p-value is less than 0.05, the difference between the springs is significant.

Fig. 4 shows a positive correlation between conductivity and Skunk Cabbage abundance, which indicates that higher mineral content in the water may be linked to greater cabbage growth.

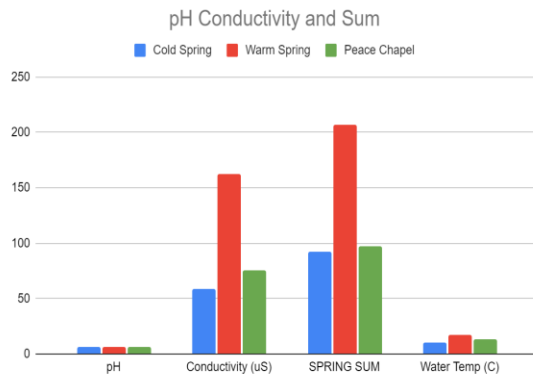


Figure 4. Warm Springs had the highest conductivity, sum, and water temperature. All three springs had similar pH values, but Peace Chapel had the highest.

Fig. 5 shows that when comparing pH to Skunk Cabbage totals across the three study sites, including Warm Spring, Cold Spring, and Peace Chapel, a positive correlation was observed. As the water temperature increased, so did the total count of Skunk Cabbages. This indicates that warmer water temperatures may create conditions more favorable to the growth of Skunk Cabbage.

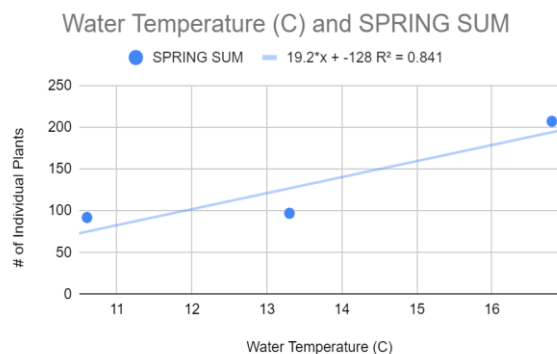


Figure 5. When comparing the water temperature to the skunk cabbage total for each site, we found a

positive correlation. Warmer waters could be more favorable for skunk cabbage growth.

Fig. 6 examines the relationship between water conductivity and Skunk Cabbage abundance at each site. Conductivity is a measure of the concentration of dissolved salts or minerals in water, which have the ability to impact plant growth in aquatic ecosystems. The positive correlation we observed indicates that higher water conductivity may be associated with having a greater Skunk Cabbage abundance.

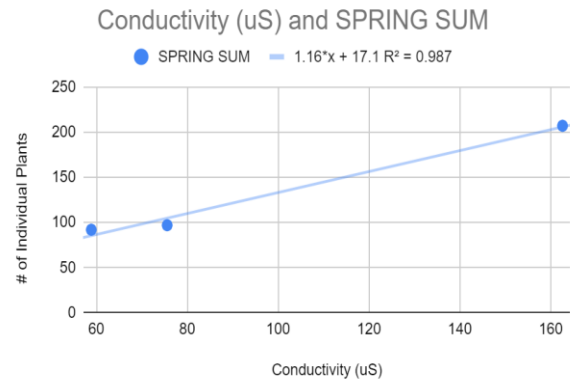


Figure 6. When comparing the water conductivity to the skunk cabbage total for each site, we found a positive correlation. Higher conductivity might be more favorable for skunk cabbage growth.

Fig. 7 compares the water pH to the total Skunk Cabbage count at each site. Water pH is a helpful measure of acidity or alkalinity in an environment, with 7 being a neutral pH. In this case, we found no real relationship between water pH and Skunk Cabbage abundance.

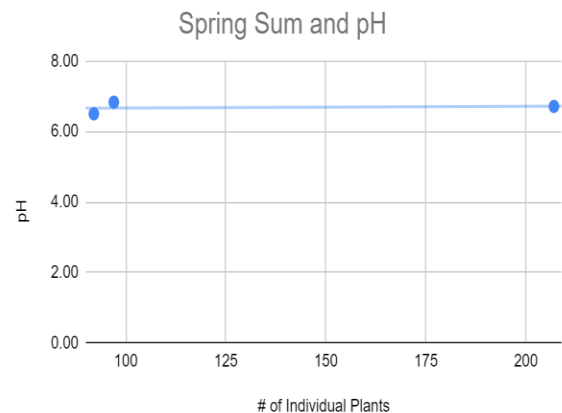


Figure 7. When comparing the pH to the skunk cabbage total for each site, we did not find a clear relationship. The pH values for each site were very similar, and we did not have great confidence in our pH meter's reliability.

DISCUSSION

The objective of this study was to investigate the different factors that affect the abundance of Easter Skunk Cabbage (*Symplocarpus foetidus*) in three separate springs in Huntingdon, Pennsylvania. Our analysis revealed a few trends and relationships that can inform our understanding of Skunk Cabbage ecology. Out of the three springs examined, Warm Spring had the highest sum and average skunk cabbage abundance. It also had the highest conductivity and water temperature. Peace Chapel had the second highest values for all of those categories, and Cold Spring had the lowest. The pH values for the springs were all similar, though Peace Chapel was the highest. With a Kruskal-Wallis test, we found that there was a significant difference in skunk cabbage abundance per plot between the three sites.

Our results show some evidence for factors affecting the skunk cabbage abundance. Conductivity and water temperature both had a positive correlation with total skunk cabbage counts. The conductivity-abundance relationship was especially strong, with an R^2 value of 0.987. However, there was no significant relationship found between pH and abundance. Overall, conductivity was our strongest predictor of skunk cabbage abundance. Because of our limited sample size and equipment, further research should be conducted to further test this relationship.

Future research projects could look into gathering data from other local skunk cabbage populations and comparing it to this data. Other factors that could be interesting to analyze are light levels, salinity, competing/cohabitating species, and soil type. It could be interesting to compare skunk cabbage populations that do not grow along water to those that do.

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