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# EFFECT OF WATER QUALITY ON SALAMANDER DIVERSITY WITHIN LOCAL STREAMS

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## ABSTRACT

Salamanders prefer very specific water conditions and thus are capable of being biological indicators. For our research we decided to sample Warm Spring and Cold Spring for the species of salamander along with the water quality of the springs. The northern dusky (*Desmognathus fuscus*), northern red (*Pseudotriton ruber*), and the northern two-lined (*Eurycea bislineata*) were observed at both springs, while the spring salamander (*Gyrinophilus porphyriticus*) was only observed at Warm Spring. More studies should be conducted to understand why the spring salamander seems to prefer Cold Springs.

*Keywords: biological indicator, freshwater springs, pH, salamander, water quality*

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## INTRODUCTION

Biological indicators are species, communities, or biological processes that are used to assess the quality of the environment and how it changes over time. Specifically, species used as biological indicators are chosen because they exhibit a measurable response to stress that is reflective of the whole ecosystem. Additionally, using bioindicators can serve as a cost-effective alternative to chemical sampling (Holt and Miller 2010). Amphibians, especially plethodontid salamanders, are seen as prime examples of valuable indicator species because of their dual life histories and permeable skin and eggs. (Siddig 2018). “Their (salamanders) longevity, small territory size, site fidelity, sensitivity to natural and anthropogenic perturbations, tendency to occur in high densities, and low sampling costs mean that counts of plethodontid salamanders provide numerous advantages over counts of other North American forest organisms for indicating environmental change.” (Welsh, et. al 2002). Typically, changes in salamander communities can reflect changes in moisture, succession, and trophic disturbances. Central Pennsylvania is home to numerous types of plethodontid salamanders, including the redback,

eastern newt, and slimy salamander (Pennsylvania Fish and Boat Commission). Pennsylvania is also home to many natural springs, which, despite the perception of clean, untainted water, have the potential to be polluted and disease-ridden (Boser et. al, 2016) . The presence of salamanders at specific spring locations may coincide with certain qualities of the springs, elucidating their true health. We propose that the species and number of salamanders found to be inhabiting Warm Spring will differ from that of Cold Spring due to variances in pH, temperature, dissolved oxygen, and other water quality factors.

## METHODS AND MATERIALS

We took water quality measurements and sampled for salamanders in Warm Spring and Cold Spring. We recorded water temperature, dissolved oxygen, conductivity, and nitrates of the sites. We also surveyed the surrounding area taking note of dominant vegetation and the weather at the time of visit. Water quality was recorded in the afternoon. We would begin our salamander sampling in the evening after sunset where we would walk a total of 60 steps (roughly 60

feet) along the edge of the spring, setting up our transect area. As we followed the bank of the spring, we would sample 3 feet into the water and 3 feet on land. When a salamander was collected, we would photograph to confirm identifications and record the snout vent length before releasing back into the spring. In traveling between locations, waders and materials were disinfected. At a later date, we returned to the photographs and identified them with the help of Dr. John Matter.

### SITE LOCATION

Cold Spring is a cool, acidic spring located off of Cold Springs Road. The water was clear, with minimal algae and marsh marigold cover. Vegetation surrounding the stream consisted mostly of grass, with some trees, flowers, and skunk cabbage. Stream flow was moderate, and sediment was made up of gravel, sand, silt, and cobbles. Other observed aquatic life included wood frogs and American toads.

Warm Spring is a warm, alkaline spring located off of Cold Springs Road, about 2 miles away from Cold Spring. The water was clear aside from plant coverage, which consisted of moss, duckweed, and algae. The area surrounding the stream was muddy and saturated, and vegetation consisted of some grass and plentiful skunk cabbage. Water movement was relatively slow and the sediment was made up of gravel, sand, silt, and cobbles. Other aquatic life included various frog, fish, and macroinvertebrate species.

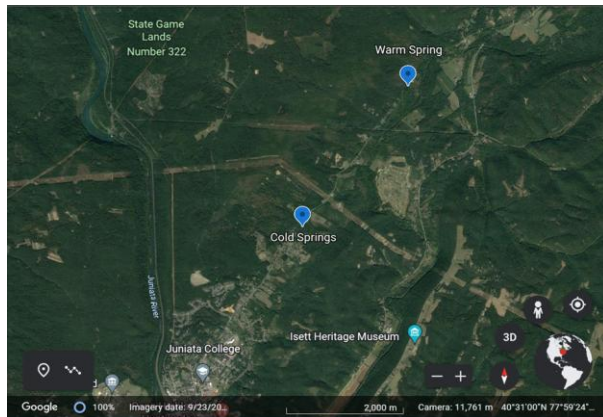


Figure 1. Map of sampling locations, Cold Spring and Warm Spring, in Huntingdon, PA, 16652

### RESULTS

Overall, 4 different species of salamanders were observed between both springs. The northern dusky (*Desmognathus fuscus*), northern red (*Pseudotriton ruber*), and the northern two-lined (*Eurycea bislineata*) were observed at both springs, while the spring salamander (*Gyrinophilus porphyriticus*) was only observed at Cold Spring (Table 1). Snout vent length of the salamanders was also collected and averaged (Figure 1). We used a 2-tailed, paired t-test to determine the significance of amounts of individuals between the cold and warm sampling groups (Table 2). Our calculated p value was 0.263, which means that the difference in the number of individuals between the springs was not significant. The t-Value was 1.54. Our Simpson’s Diversity index was 3.3 at Cold Springs and 2.5 at Warm Spring (Table 3). This demonstrated the species abundance and species observed at each spring. Lastly, we recorded water quality at each of the springs (Table 4).

COUNT of Species	Location		
Species	Cold	Warm	Grand Total
Northern Dusky	4	22	26
Northern Red	9	15	24
Northern Two-Lined	7	43	50
Spring Salamander	6		6
<b>Grand Total</b>	<b>26</b>	<b>80</b>	<b>106</b>

Table 1. Sum of all individuals observed at both sites.

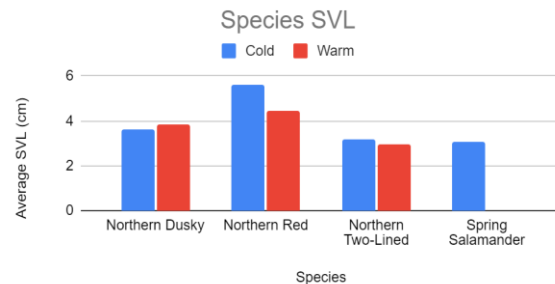


Figure 1. Average snout vent length in centimeters of each species observed at Cold and Warm Springs.

Table 2. Sum of all individuals observed at each site, separated by sample, on which the t-test was performed.

<i>COUNT of Species</i>	<i>Location</i>		
<i>Sample</i>	Cold	Warm	Grand Total
1	8	34	42
2	15	10	25
3	3	36	39
<b>Grand Total</b>	<b>26</b>	<b>80</b>	<b>106</b>

Table 3. Simpson's Diversity Index calculated from total abundance and species richness at each location.

Location	Diversity Index
Cold	3.3465
Warm	2.5020

Table 4. Average water quality taken at Cold and Warm Springs.

Site Water Quality	Temperature (C)	Nitrates (ppm)	Conductivity (ppm)	Dissolved Oxygen (ppm)	pH
Cold Springs	10.73	1.67	25.43	7.41	4.32
Warm Springs	16.70	5.00	109.50	5.42	6.84

## DISCUSSION

Although more individuals were found in Warm Springs than Cold Springs (Table 1), this difference was not significant (Table 2). As a result, the diversity indexes calculated for each stream did not differ significantly because most species were found at both sites (Table 3). Yet the spring salamander was not found at both sites, and it is likely due to the differences in water quality (Table 4). Looking at water quality of Warm Spring and the number of individuals found there it can be inferred that salamanders prefer a warmer, more basic pH compared to the colder and more acidic water of Cold Spring. Further, the compositions and flow of the springs differ greatly from one another. Warm Spring has an extremely saturated marsh surrounding the spring, a sand and silt bedding with numerous large rocks, and significant amounts of moss, duckweed,

and algae covering the water along with a slow flow rate. This gives the salamanders plenty of space and cover from potential predators. In contrast, Cold Spring consists of forest surrounding a fairly solid cobble bedding with intermittent silt and sand bedding, and while there are many large rocks the spring itself has a fast rate of flow with few slow-moving areas, which salamanders prefer. Just looking at the difference in the number of specimens found (with the same amount of time and effort dedicated to each search) indicates that there is the potential of preference regarding water quality in habitat selection, or, benefits of qualities of water and cover that allow them to have more reproductive success. In relation to water quality of the springs, we discovered Spring Salamanders at only Cold Spring. With what we know of salamanders' preferences it would be thought that they would have been found in Warm Spring, but they were not. A possible explanation for this could be the slightly higher dissolved oxygen in Cold Spring, and the considerably lower nitrate concentrations.

A further study that could be conducted to expand our knowledge would be a transplant study of spring salamanders. This would clarify the reason why spring salamanders weren't found there— can they not get there, or is the habitat not suitable? It is possible that either the warmer temperature, differences in vegetation, or higher pH is not conducive to optimal spring salamander habitat. This experiment could be conducted by collecting water from warm springs and maintaining the temperature with a heater. This isolates the pH and temperature component. Further on, individuals could be released to the spring to be collected later. If the habitat is unsuitable at this point, it is probably due to biotic factors like competition and predation.

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