

## EFFECTS OF pH AND NICHE PARTITIONING ON THE ABUNDANCE AND DISTRIBUTION OF WOOD FROG AND SPOTTED SALAMANDER EGG CLUSTERS

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### ABSTRACT

Spotted salamanders (*Ambystoma maculatum*) and wood frogs (*Rana sylvatica*) in wooded areas of Pennsylvania use vernal pools as sites for reproduction. We hypothesized that abundance of wood frog and spotted salamander egg clusters would be affected by the pH of vernal pools. In addition, we hypothesized that spotted salamanders and wood frogs should use niche partitioning to avoid direct competition. We found that pH does not directly affect the abundance of frog egg clusters ( $r = -0.596$ ,  $P = 0.157$ ) or salamander egg clusters ( $r = -0.364$ ,  $P = 0.422$ ) in vernal pools. Nor does niche partitioning appear to affect the location of amphibian egg clusters in vernal pools. Further research is necessary to determine if other biological and chemical factors affect the abundance of amphibian eggs in vernal pools.

*Keywords:* egg clusters, mole salamander (*Ambystoma maculatum*), niche partitioning, vernal pools, wood frogs (*Rana sylvatica*)

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### INTRODUCTION

The spotted salamander, *Ambystoma maculatum*, ranges throughout Pennsylvania (Shaffer, 1991). The spotted salamander is an early spring breeder that migrates to vernal pools at the onset of warm rains (Conant and Collins, 1998). Spotted salamander eggs are deposited in vernal pools attached to plants or underwater structures (Shaffer, 1991). The wood frog, *Rana sylvatica*, ranges throughout Pennsylvania, mostly in woodland settings (Heinrich, 2000). Warm rains are a signal for wood frogs to lay their eggs in vernal pools (Shaffer, 1991). The eggs are deposited on, or near vegetation that is just below the water's surface (Heinrich, 2000). The eggs are black and encased in a clear jelly-like mass. The wood frog lays between 2,000 and 3,000 eggs in clusters (Heinrich, 2000). These gelatinous eggs are hygroscopic, and swell by absorbing water to increase surface area exposed to the sun (Heinrich, 2000). Because vernal pools form from rainwater, which is generally acidic in Pennsylvania, we hypothesized that the abundance of spotted salamander and wood frog egg clusters should be positively correlated with pH in vernal pools. In addition, we hypothesized that the abundance and distribution of wood frog and spotted salamander egg clusters should be negatively correlated in vernal pools, due to niche partitioning. This study is important because amphibian populations are declining, which has been attributed to habitat destruction, acid precipitation, chemical pollution, introduction of exotic species, increased ultraviolet radiation and human harvesting (Blaustein, Wake and Sousa, 1994). From a previous study, it was determined that the populations of both the spotted salamander and wood frog are fluctuating (Blaustein Wake and Sousa,

1994). Therefore, our intention was to see how pH and niche partitioning may affect the abundance and distribution of wood frog and spotted salamander egg clusters in vernal pools.

### FIELD SITE

We began by scanning an area located along Petersburg Pike, in Huntingdon County, Pennsylvania for vernal pools with amphibian eggs. This was done from March 31, 2002 through April 18, 2002. Data were collected from seven vernal pools. These seven vernal pools can be broken down into four areas (Fig. 1). The first area was directly next to Petersburg Pike, containing two vernal pools in close proximity. These two vernal pools are referred to in Table 1 as Petersburg Vernal Pool 1 and Petersburg Vernal Pool 2. Area two consisted of three vernal pools located roughly one mile from the first area on residential property. These three vernal pools were in close proximity of each other, separated by a distance of approximately 50 m. These three vernal pools are referred to as The Lane 1, 2 and 3 in Table 1. Area three had one vernal pool, which was located on residential property half way between area one and two. This vernal pool is referred to as Yellow House Vernal Pool. The last area was located across from area two on the other side of Petersburg Pike. This vernal pool is referred to as the Roadside Vernal Pool. All seven vernal ponds had similar poolside vegetation.

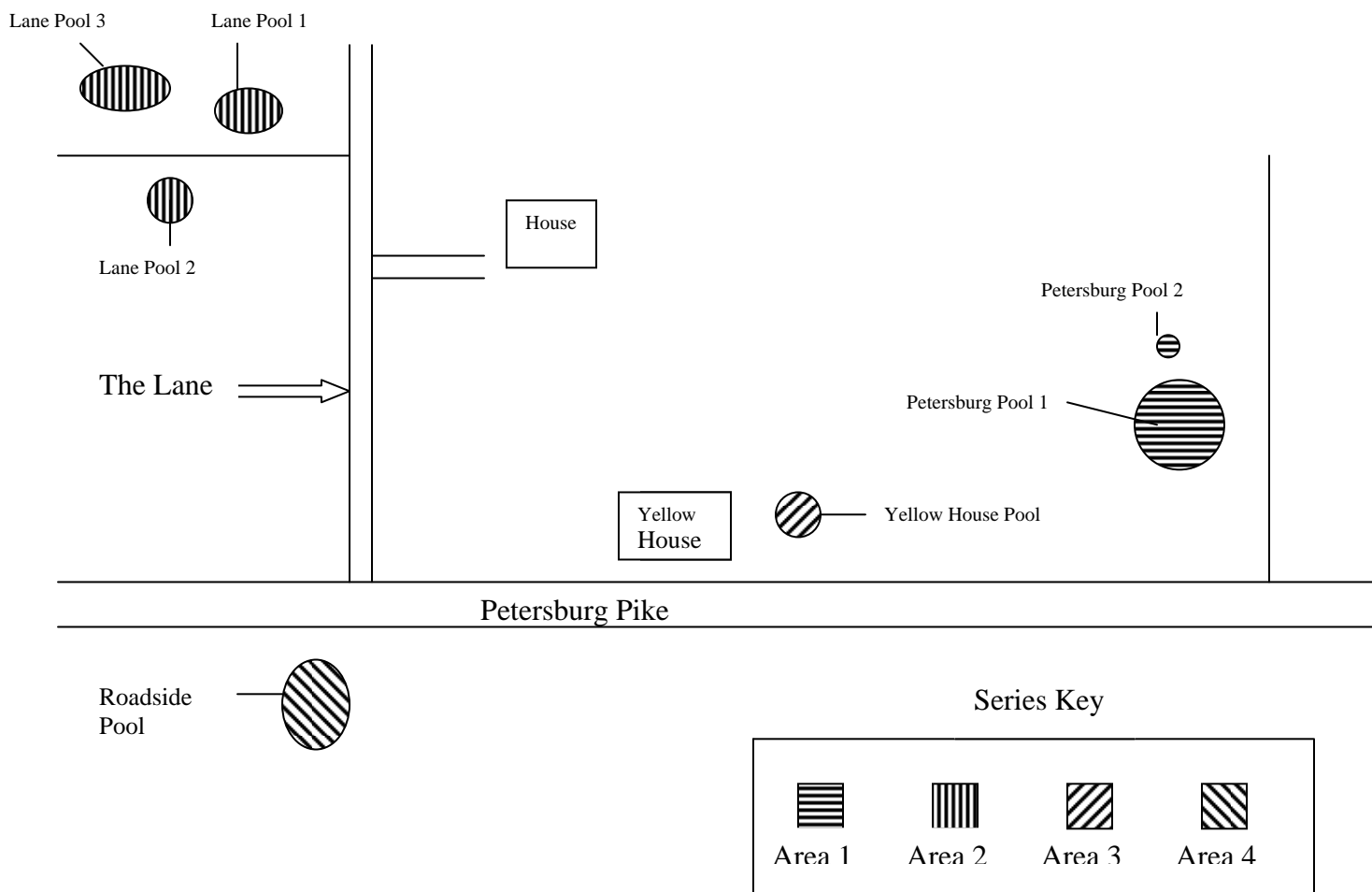


Figure 1. Drawing of vernal pool locations.

	Petersburg Vernal Pool 1	Petersburg Vernal Pool 2	The Lane Vernal Pool 1	The Lane Vernal Pool 2	The Lane Vernal Pool 3	Roadside Vernal Pool	Yellow House Vernal Pool
Number of Frog Egg Clusters	67	1	219	22	56	43	3
Number of Salamander Egg Clusters	69	2	205	17	217	741	0
Depth (cm)	38.9	30.8	18.1	41.4	36.9	16.4	7.9
Temperature (°C)	12.7	9.3	10.7	11.5	11.3	10.5	12.1
Conductivity (microsiemens)	57.76	52.72	68.91	52.32	68.32	65.88	65.92
pH	4.88	4.55	3.57	3.75	3.98	4.59	6.43

Table 1. Selected physical and chemical characteristics of seven vernal pools.

## MATERIALS AND METHODS

Physical and chemical characteristics were determined for each of the seven pools (Table 1). Conductivity was measured using a conductivity meter and pH was measured using a pH meter. Physical analysis included mean depth measurements using a meter stick, temperature with a mercury thermometer, and egg counts using a transect sampling method. We counted wood frog and spotted salamander eggs in clusters. A cluster was defined as a mass of eggs that was three-inches in diameter. Correlation tests were used to determine whether number of egg clusters for each species was related to various environmental characteristics. Data were normalized by converting them to square roots. The critical  $r$ -value used was 0.754 with five degrees of freedom and alpha equal to 0.05.

## RESULTS

Number of egg clusters of wood frogs and spotted salamanders was negatively correlated with pH, though not significantly ( $r = -0.596$ ,  $P = 0.157$ : Fig. 2;  $r = -0.364$ ,  $P = 0.422$ : Fig. 2). In contrast, number of wood frog and spotted salamander egg clusters were positively correlated, though not significantly ( $r = 0.632$ ,  $P = 0.128$ : Fig. 4).

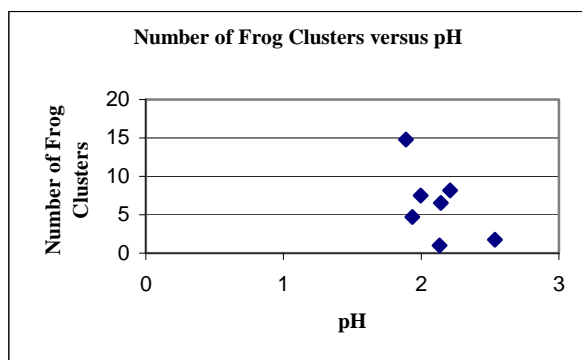


Figure 2. Number of wood frog egg clusters versus pH in seven vernal pools. Values are square-root transformed

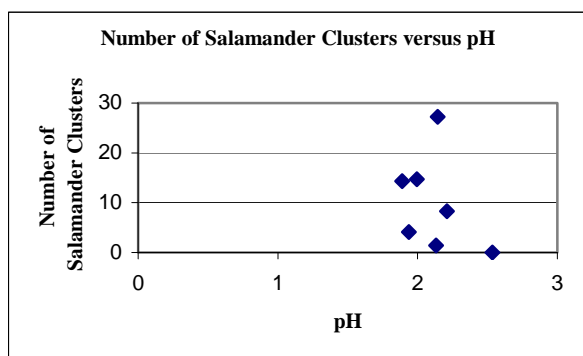


Figure 3. Number of spotted salamander egg clusters versus pH in seven vernal pools. Values are square-root transformed.

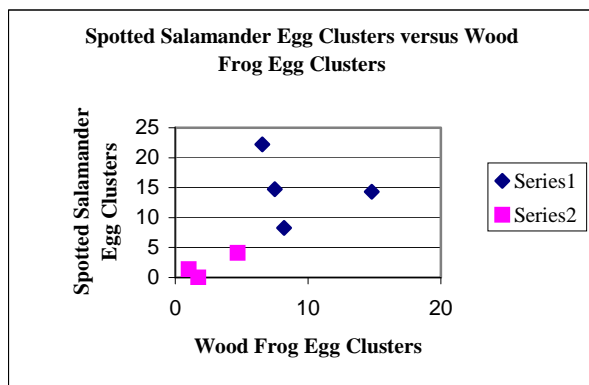


Figure 4. Association between number of wood frog and spotted salamander egg clusters in seven vernal pools. Values are square-root transformed. Series 1 vernal pools were larger than Series 2 vernal pools.

## DISCUSSION

Our findings did not support our hypothesis that the abundance of frog and salamander egg clusters should be positively correlated with pH in vernal pools. In fact there were nonsignificant negative trends between pH and the number of egg clusters (Figs. 2 & 3). This means that as the pH became more basic the number of egg clusters declined, indicating that our hypothesis of acidity limiting the abundance of egg clusters in vernal pools is incorrect. However, acidity may affect other factors such as, the rate of development and survivorship of amphibian embryos, which should be investigated.

Our hypothesis that wood frogs and spotted salamanders use niche partitioning when laying their eggs in vernal pools is not supported by our findings. There is a positive instead of negative trend between the number of frog and salamander egg clusters, suggesting that these two species are not competing for breeding sites (Fig. 4). However, we have observed that wood frogs and spotted salamanders lay their eggs at different water depths. Spotted salamander eggs were located on the bottom of vernal pools attached to plants and underwater structures, as suggested by Shaffer (1991). Wood frog eggs were located near the surface of the vernal pools as supported in previous research (Shaffer, 1991). In Figure 4 the data are grouped by vernal pool size. The vernal pools represented by Series 1 are larger and more permanent than the vernal pools represented by Series 2. The vernal pools represented by Series 1 are the Roadside Vernal Pool, The Lane Vernal Pool 1, The Lane Vernal Pool 3, and Petersburg Vernal Pool 1 (Fig. 1). The vernal pools represented by Series 2 are Petersburg Vernal Pool 2, The Lane Vernal Pool 2 and Yellow House Vernal Pool (Fig. 1). Interestingly, Series 1 vernal pools had a higher abundance of egg clusters than smaller Series 2 vernal pools. Perhaps, the abundance of egg clusters in Series 1 is greater because a large vernal pool lessens the risk of predation, lowers the acidity per egg, and reduces convection heat loss per egg cluster (Heinrich, 2000). These ideas need to be tested.

Further studies should be based on larger numbers of vernal pools, and the effect of water chemistry on survivorship and development of amphibian embryos should also be examined, possibly by using transplant studies.

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### **LITERATURE CITED**

- Blaustein, A., W. Sousa and D. Wake. 1994. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinctions. *Conservation Biology* **8**: 60-71.
- Conant, R. and J.T. Collins. 1998. A field guide to reptiles and amphibians: Eastern and Central North America. Houghton Mifflin Company, Boston, Massachusetts, USA
- Heinrich, B. 2000. Everbody into the pool. *Natural History* **109**: 18-19.
- Shaffer, L.L. 1991. Pennsylvania amphibians & reptiles. Pennsylvania Fish Commission Bureau of Education and Information, Harrisburg, Pennsylvania, USA.