The Periglacial Legacy and Future of Vernal Pools in the Ridge and Valley Province Of Pennsylvania

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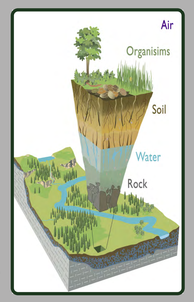
CZO
Susquehanna Shale Hills
Critical Zone Observatory

Critical Zone Science

"Critical Zone Observatories (CZOs) are natural watershed laboratories for investigating Earth surface processes mediated by fresh water. Research at the CZO scale seeks to understand these little-known coupled processes through monitoring of streams, climate/weather and groundwater. CZOs are instrumented for hydrogeochemical measurements and are sampled for soil, canopy and bedrock materials. CZOs involve teams of cross-disciplinary scientists whose research is motivated and implemented by both field and theoretical approaches, and include substantial education and outreach."

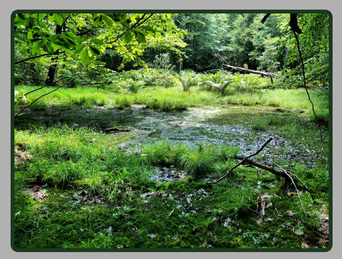


The research presented here has been years in the making. Built from the undergraduate senior thesis work done by Kimberly Schmidt and collaboration with REU mentor Dr. White.

What is a.....

Vernal Pool?

Seasonal depression wetlands that range in size from a small puddle to several square meters. These areas are ecologically senstive due to their roll in the reproduction and habitat needs for many amphibians, insects, and other organisms. Due to their size and seasonality the effects of temperature and precipitation changes can greatly impact the array of processes that these areas support.



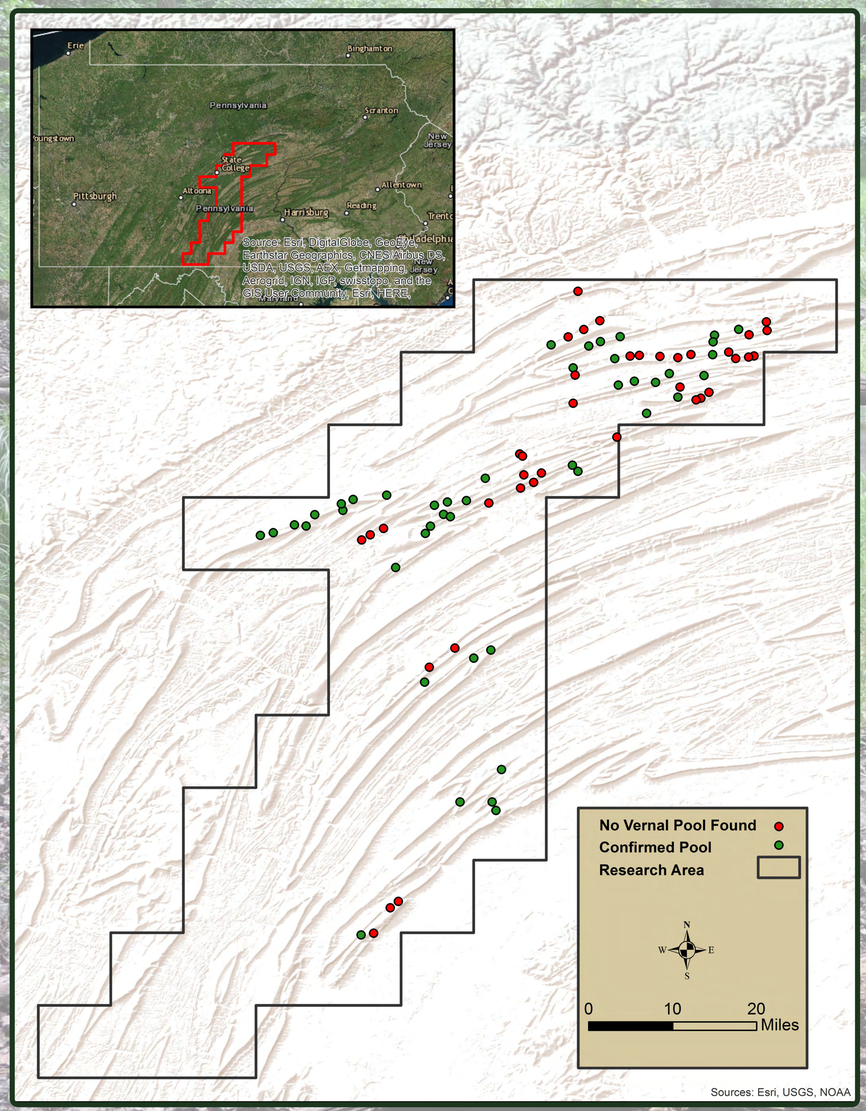
Pingo?

During the last periglacial period in central Pennsylvania ground water coming in contact with the permafrost surface lead to the development of ice-cored hills referred to as pingos. These mounds of ice grew and retreated as the cycle of permafrost changed. Over time their presence and subsequent disappearance led to the formation of depressions, which set the conditions for possible wetland establishment. There are many reasons for wetlands to develop, but with the periglacial and soil permafrost legacy in this region there has been research showing the correlation between the presence of pingo scars and wetlands. (Marsh 1987)

Photo Source: http://icestories.exploratorium.edu/dispatches/mysterious-ground-ice-feature/

Hydrologic Importance

Wetland depressions found in saddle areas throughout the ridge and valley physiographic province are valuable beyond the habitat and life cycle needs of the local wildlife. Their position hydrologically down gradient from the ridge tops and above the surface headwaters demonstrates their possible influence on downstream water quality. As human activity in proximity to these areas changes and the effects of climate change become more pronounced it is unknown how these unique systems will respond. As a forward thinking scientific community, research and conservation must be stressed now before it is too late.



Statisical Highlights

Number of sites visited	83
Area of research area	2557 square miles
Saddles with pools found	45
Individual pools	107
Average pool size	3914 square feet
Largest pool	27,582 square feet
Smallest pool	74 square feet
Saddles with no pools found	38
Sites with no pools but showing signs of degradation from logging, road, or residential development	20
Total area of all pools found	9.7 acres

References

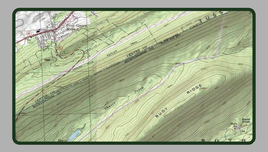
Marsh, Ben. *"Pleistocene pingo scars in Pennsylvania".* Geology v. 15 (1987): 945-947. Print.
Environmental Protection Agency. *"Vernal Pools".* United States Government. 2016.
Critical Zone Observatory. *"Description of the CZO Program".* National Science Foundation.
Kimberly Schmidt. *"Recognition and importance of relict periglacial pingo scars as biodiversity hotspots and headwater recharge zones in the valley and ridge physiographic province, central Pennsylvania"* The Pennsylvania State University. 2016.

Methodology

Multiple sources of information and field techniques come together to identify potential vernal pool sites and to locate them.

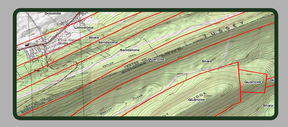
Topography

Quadrangle maps with elevation contour lines are utilized to determine the location of saddle areas among the parallel ridgelines.



Bedrock

The underlying geology contributes greatly to the transmissivity of the nearby ground water. The ridgelines are underlain with sandstone and quartzite, and mantled with boulders and sand. These conditions readily allow water drainage from the slopes of the ridgeline to the much less permeable layer of shale in the saddle.



Field Surveying

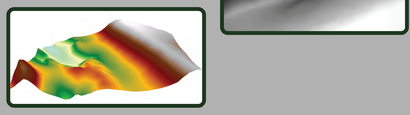
Once potential sites are identified a field technichian must visit the location for a site survey. Pictures and GPS tracks are taken to record the present state and size.

Vegetation

Certain species of plants thrive in hydrologically active soils. Sensitive fern seen below is an obligate wetland plant. Grasses, sedges, ferns, and Black Gum (*Nyssa sylvatica*) are common.

Spatial Analysis and Modeling

Not all saddles have the conditions necessary for the development of vernal pools. Common reasons why some areas are more suitable than others center on the location's size, relief, and aspect. Saddles have been evaluated using digital elevation models and ArcGIS. As the dataset grows these tools will become even more vital in teasing out which areas have the most potential. The images to the right show a DEM and a three dimensional view of a saddle.



Future Prospects

There are many locations that still need to be visited, but there are obstacals in the way. These range from access issues onto private land, terrain navigatability, and continued institutional support for the research. After visiting sites up and down this region in Pennsylvania it is clear that these areas deserve to be protected, and it can no longer be put off until a more convienant time.