An Ecological Spring Awakening in Our Vernal Ponds

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"How suddenly they awake! Yesterday, as it were, asleep and dormant, today as lively as ever they are. The awakening of the leafy woodland pools."

This observation from the March 15, 1860 journal entry of Henry David Thoreau, the revered New England author and naturalist, highlights the activity and excitement surrounding vernal ponds as they usher in the spring season. Vernal ponds (also called vernal pools or temporary woodland ponds) are unique habitats on the landscape, and serve as excellent sinks of resources when they are holding water. Decaying leaves and other organic material serve as the foundation of a surprisingly complex food web, which ranges from bacteria to large aquatic insects. Several land-dwelling species also take advantage of the vernal bounty – snakes and raccoons are often seen loitering around vernal ponds late in the season, looking to nab a tasty tadpole or newly metamorphosed frog.

A spotted salamander adult arrives at a pond in southern Connecticut to breed in March.

However, a vernal pond is a temporary habitat with ephemeral resources. True "vernal" pools fill with water in the spring from snowmelt and rainfall. In this region, we have what are technically "autumnal" pools – filling up in the autumn. Filling occurs once leaves have fallen from deciduous trees and the roots are no longer drawing water from the pond basin for the leaves (a process called transpiration). So these pools often fill in late fall, remain frozen during winter, and usher in the spring breeding season as soon as they thaw. If encountered regularly, you may notice that vernal ponds will not lose much water until around mid-May, coinciding with the formation of leaves on trees, which essentially act as straws sucking water out of the pond.

Two images from the same vernal pond in central Connecticut. The first photo was taken in early April when the pond was teeming with activity below the water's surface. The second photo shows the same pond basin in late July of the same year.

Life Abounds

At its peak, a vernal pond is teeming with submerged activity. Fairy shrimp amble rhythmically through the water. Caddisfly larvae rummage around for materials to build their protective cases. Dragonfly larvae sit and wait for an unsuspecting victim and then – in one quick strike – they capture and consume. Several turtle species travel through the pond to munch on amphibian eggs. Microscopic zooplankton stutter through the water in quick bursts. Mosquito larvae wriggle to evade capture by salamander larvae. Snails and fingernail clams saunter slowly along the bottom. Leeches look nothing like their blood-sucking form as they glide by with ribbon-like grace. Diving beetle larvae and giant water bugs lurk beneath the surface, capturing prey many times their size, injecting digestive enzymes, and then siphoning the liquefied remains. Many species of algae also inhabit vernal ponds, including *Oophila amblystomatis*, a symbiotic species that colonizes amphibian eggs and uses the carbon dioxide generated by developing embryos to produce oxygen for the eggs via photosynthesis.

Mating adult wood frogs depositing eggs near the water surface. The smaller male (on top) clasps the female and fertilizes the eggs as they exit her body. The egg mass is deposited at a communal egg mass site – often the warmest area of the pond.

Amphibians are recognized as the quintessential vernal pond inhabitants, serving as endearing ambassadors to the public. Blue-spotted and Jefferson salamanders are the first to arrive at the ponds, often before the ice melts entirely (early to mid-March in southern New England). Moving during the first warm rain after a mild stretch of weather, wood frogs only trail them by a week or so. Male wood frogs form loud choruses – a cacophony of "quacking" intended to attract the females trickling into the pond. This little frog will lay an egg mass smaller than a golf ball yet containing, on average, 800 eggs. Within hours, the mass (attached to vegetation near the surface) will absorb water and swell to the size of a softball. Most female wood frogs will deposit their egg masses communally in the same location, which provides warmer temperatures for the eggs than if they were laid separately.

Male spotted salamanders enter the pond around the same time as wood frogs, depositing packets of sperm on the pond bottom. Once the eggs are fertilized, female spotted salamanders will lay their egg masses on submerged vegetation. In some ponds, the developing eggs of spring breeding amphibians are not always the first to arrive. If winter has not been too harsh (and the water did not freeze to the bottom), larval marbled salamanders have been biding their time since being laid as eggs in the dry pond the previous autumn. When the eggs of the spring-breeding species begin to hatch, marbled salamander larvae could be lurking and gorging on the hatchlings.

Survival of the Fittest

Once deciduous leaves emerge and the water level of the pond begins to drop, the race is on. All of the amphibian species present in the pond as larvae share one critical goal – to get out of the pond before it dries. This depends on the pond holding water long enough for the amphibians to develop from egg to larvae and through metamorphosis – the amazing transformation of the body from a swimming aquatic form to one better suited for a terrestrial life on the forest floor. This includes the loss of gills and development of four limbs. Except in wet years, most vernal ponds will dry entirely by late summer. While this is a challenging environment, regular drying of the pond prevents many predatory species, especially fish, from living there.

Even in years with average precipitation there is evidence that the typical vernal pond in this region does not hold water long enough to allow metamorphosis. This leads to boom-bust cycles in reproductive output – more years of very low survival interspersed by years with huge numbers of larvae making it to the terrestrial adult stage. Too many consecutive bust years and the local population within that pond will go extinct. Fortunately, one productive boom year can produce enough adults that many will leave that pond in search of an area with less competition for resources – thereby recolonizing ponds left unoccupied by earlier local extinctions.

Conservation of Vernal Ponds – Connections Matter

These extinction/recolonization events are mismatched among ponds and across years, and this asynchrony means that some populations will do very well while others will decline. For this reason, thinking about vernal ponds as single, isolated entities is of limited utility. The only way to ensure the long-term persistence of vernal pond communities is to think of them as networks of ponds interconnected by animals dispersing between them. Ideally, this means taking a comprehensive look at landscape management to ensure that both vernal ponds and upland forest habitats are protected as a unit, rather than regulating individual wetlands in isolation. This landscape approach need not preclude development either. In neighboring states, land development companies and landscape architects are collaborating to test whether residential developments can be successfully integrated into areas with vernal ponds so that amphibian populations persist within the new landscape.

An amazing diversity of life arrives to take advantage of the temporary flood of nutrients contained within these habitats. Generally, vernal pond species are doing well within intact, forested landscapes across southern New England. So, as the warming weather of spring entices you out of hibernation and into the woods, keep an ear open for the "quacking" of wood frogs. Detour off the trail and follow the chorus to one of Connecticut's most fascinating habitats – and plan to revisit several times during the year to fully appreciate their evanescent charm.