

BY SUSAN HAND
SHETTERLY
PHOTOGRAPHS BY
TRISTAN SPINSKI

Where the Forest Springs Eternal

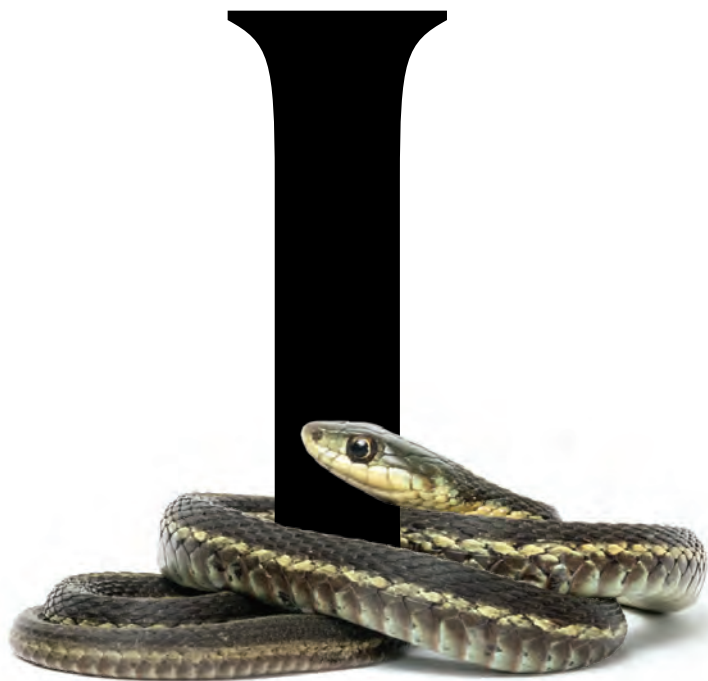
Seasonal rains fill small, watery oases called vernal pools that deliver a crucial burst of life.

Then they vanish—until it's time for the annual cycle to begin again.

A dappling of spotted salamander eggs, some infused with the algae that will help sustain them as they hatch, floats near the surface of a vernal pool in Maine. Fed by rainwater, seasonal, pop-up ponds are vital to the forest ecosystem.



A pair of wood frogs mates in the shallows of a vernal pool during the annual breeding migration in Maine. Steady evening rain and temperatures around 40 degrees prompt masses of frogs and salamanders to thaw and leave their winter burrows.

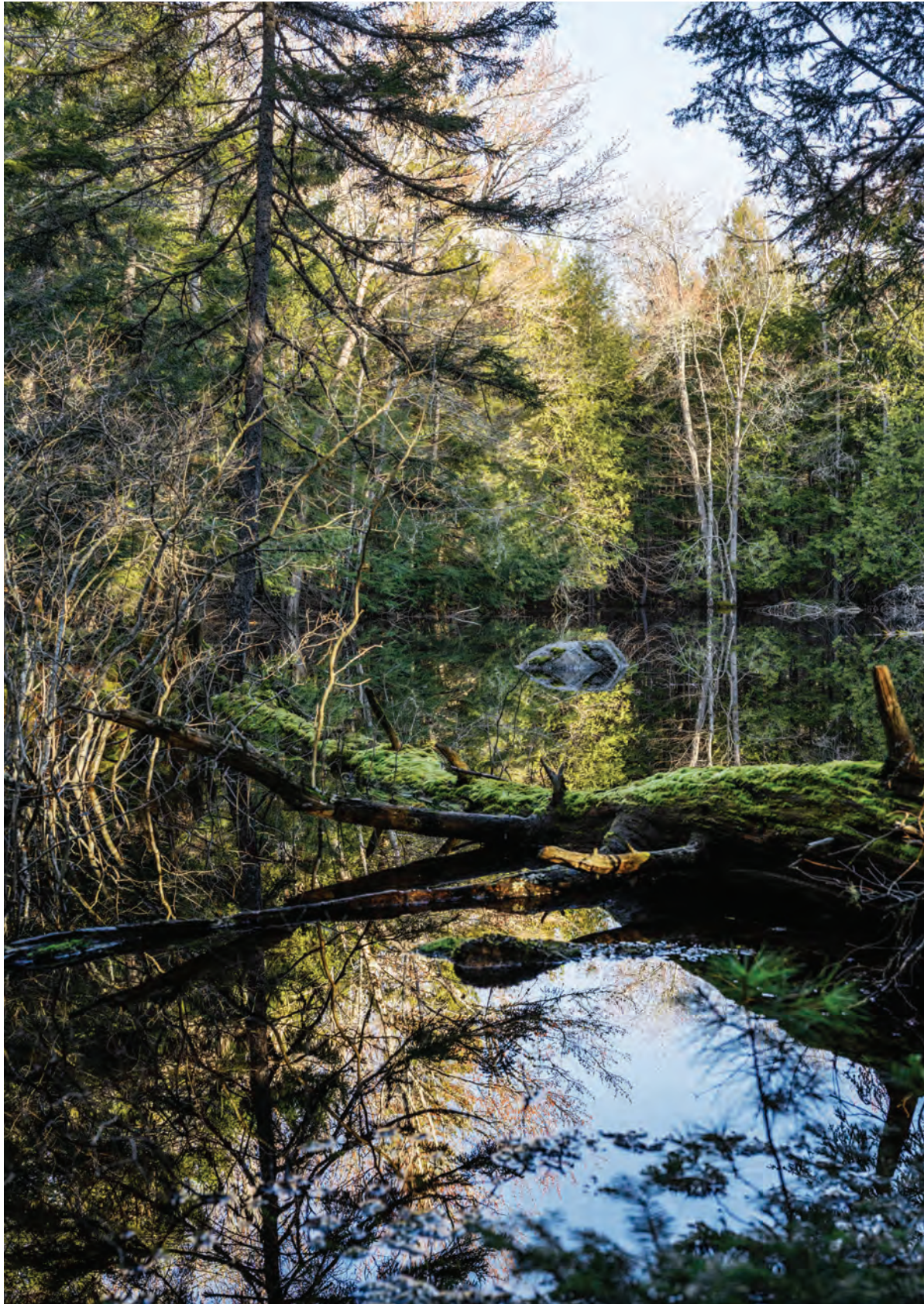


I FOLLOWED A PATH made soft by years of fallen needles through a hemlock forest. Up ahead a glow looked as if a fire had been struck in a patch of forest duff. It was sunlight, not fire, shining from an opening in the trees where a small pool bounced the light back into the air. This shallow saucer of water was a vernal pool. It was what I'd come for.

The day was late in spring, a warm afternoon, and the water in the pool had already begun to contract. Vernal pools depend primarily on rainwater and the runoff from the forest uplands. They have no permanent inlet or outlet. They are small, just a few feet deep, and often strung along the forest floor like reverse archipelagoes. As the season heats and spring rains end, they lose water to evaporation and to the roots of the surrounding trees and bushes. Most pools dry out by late summer. This is an essential quality of a vernal pool. Fish can't survive a dry-out, which means that the larvae of frogs, salamanders, all sorts of insects, and more, get a better chance to grow up.



Aram J.K. Calhoun and her husband, Malcolm (Mac) Hunter, both professors emeriti in the University of Maine's Department of Wildlife, Fisheries, and Conservation Biology, are dedicated to studying the enormous ecological impact of these tiny, ephemeral pools.

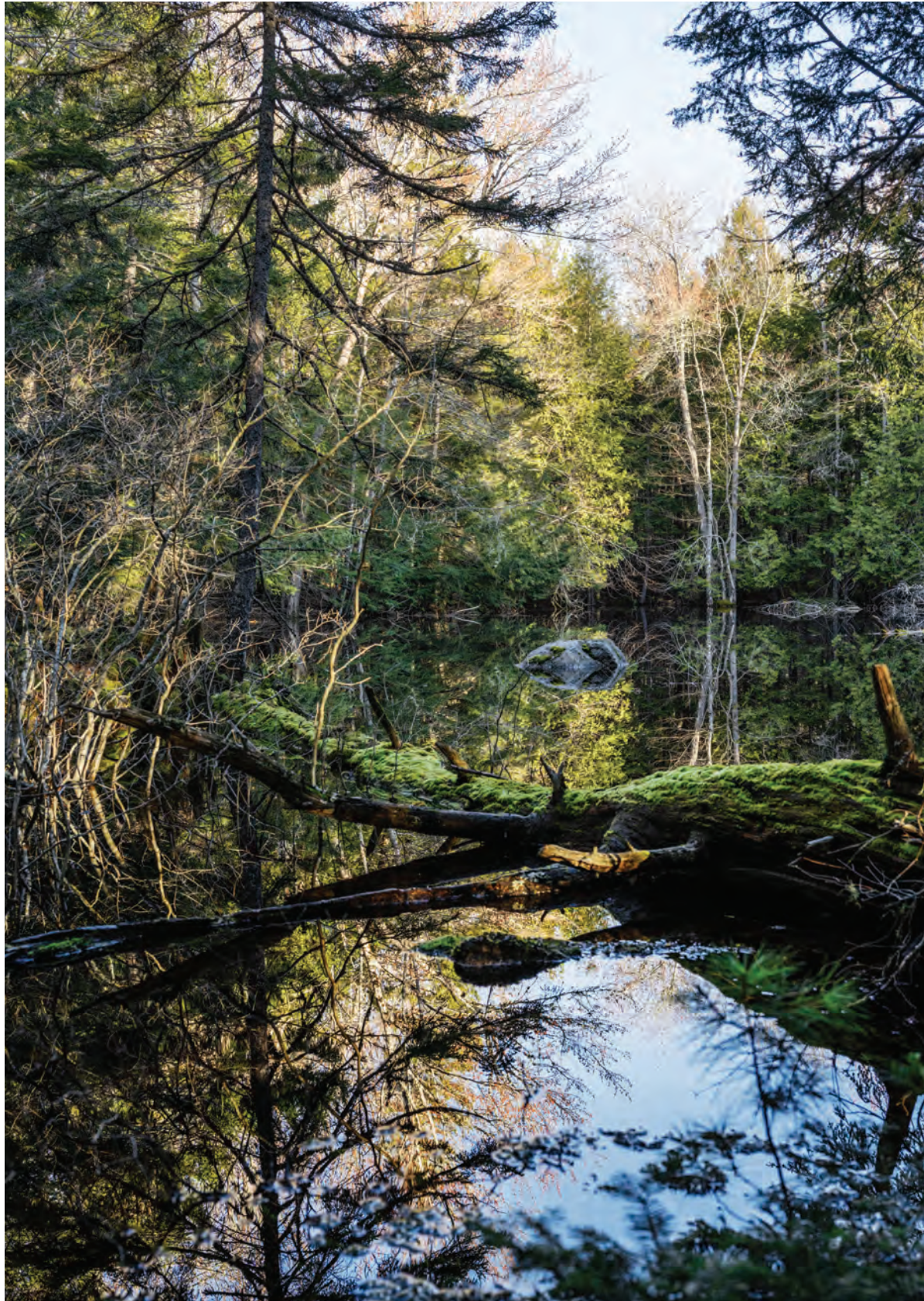


SPRING

**From the water to the land
and into the air, those that live
in these forests carry a bit of a
woodland pool within them.**



BLANDING'S TURTLE; WOOD FROG



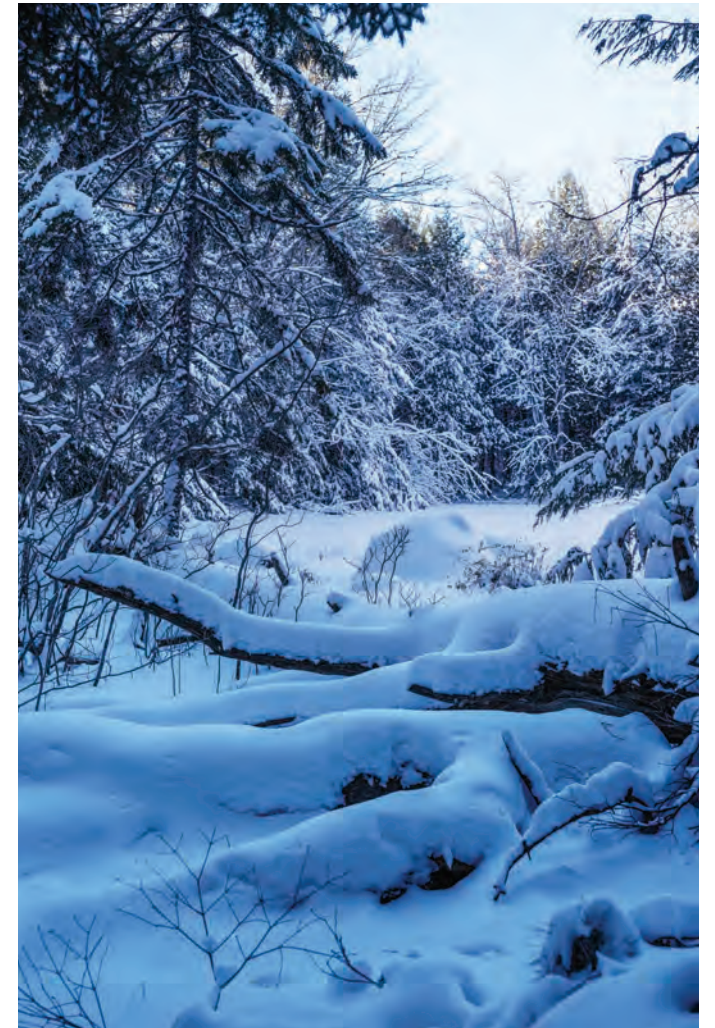
SPRING



SUMMER



FALL



WINTER

We lose landscapes and species when we don't understand and protect all the parts that make them whole.



Most vernal pools swell and surge to life each spring, only to dry down during the summer and go dormant in the winter. This annual cycle ensures that the temporary hatcheries remain free of fish, creating an ideal breeding ground for amphibians. In

Maine, wood frogs, spotted salamanders, blue-spotted salamanders, and fairy shrimps are four species that are specially adapted to thrive in vernal pools, which also become crucial water holes and feeding grounds for surrounding wildlife.

From the water to the land and into the air, those that live in these forests carry a bit of a woodland pool within them.



Midsummer water lilies sprout within many pools, providing shade for other aquatic inhabitants.



A spotted salamander deposits her egg cluster on a submerged stick during the spring mating season.



BLANDING'S TURTLE; WOOD FROG

Here in the northernmost corner of the Northeast, a wedge of glacial ice a mile high reached its heft about 20,000 years ago. Tending east, it left kettle holes, sculpted ridges, rocks the size of boxcars, and hollows of clay and moraine. These woods bear the memory of that ice. They are quick with streams, marshes and ponds, and an abundance of seasonal pools. It's as if that long-ago ice willed us the gift of water.

With their spongy margins and their uplands that contain both damp and dry refugia, all indispensable parts of one system, these pools deliver an outside burst of life to the forest. The relationship between the trees and the pools is tightly woven: The trees provide some shade to prevent a pool from drying out too soon, and they drop needles and leaves and branches into the water, rich feasts for bacteria and insects such as caddis fly larvae that in turn become food for others. Birds and bats that shelter and nest

in the surrounding trees feed on insects, and when adult and juvenile amphibians venture onto the land, many are taken by other animals. On it goes. From the water to the land and into the air, those that live in these forests carry a bit of a woodland pool within them.

We lose landscapes and species when we don't understand and protect all the parts that make them whole. As springtime ponds dry out, they can look like shallow mudholes, and when they are at the height of activity in the spring and early summer, with hundreds of lives in their warming, diminishing waters, people walking through the forest often pass them by with hardly a notice. These unprepossessing pools hide much of that kinetic energy below the surface. It reminds me of the lives of whales. How would we know that they needed our protection if all we saw were the waves?

I DRAW A SMALL NET carefully along the bottom of a vernal



pool in spring, lift it, and invert it into a glass bowl. All sorts of species emerge.

Many animals found in the pools can live well in other bodies of water, but a few are uniquely adapted to them to complete their life cycles. As April arrives and ice melts and rains sweep across the land, fairy shrimps hatch in the ponds and swim beneath a pane of thin spring ice. These crustaceans, about an inch long, paddle with ventral side up, raking the water with their abdominal appendages, which allow them to breathe and gather food as they propel themselves through the water.

Fairy shrimps have evolved not only to anticipate a summer dry-out but to require it. When a female expels fertilized eggs from her pouch, they sink to the bottom, grow for a few days, and stop. The tiny hard-shelled eggs rest in the muck of a drying pool blanketed by layers of leaves and other debris. They will hatch and grow when the rains return, their lives in sync with the pool's seasons.

Not all fairy shrimp eggs, or cysts, hatch in

a given year. They can wait 10 or 20 years, and some researchers surmise that they probably can lie in the mud of a pool for a century.

On a night of cold spring rain, wood frogs rise out of their long dormancy. The frogs spend the winter in shallow depressions, under leaves, or within fallen trees lying on the forest floor. Slick with rain, they hop toward pools that are sometimes still rimmed with ice. Researchers often refer to them as "tough" because they can live as far north as the Arctic Circle.

Wood frogs don't need to survive the cold below the frost line. When temperatures drop, their livers release a rush of glucose, which joins high urea levels in the bloodstream. This cocktail floods tissues, limiting the icy damage. The frogs are literally frozen. And appear quite dead.

The mixture sustains them through the vagaries of early spring. Often the first amphibians to reach the breeding pools, they can thaw and freeze and thaw again. Male wood frogs call to females in rough, ducklike voices. The call alerts

Teeming With Tiny Life

Vernal pools, from the Latin word for “spring,” are small bodies of ephemeral waters, formed in shallow depressions and bursting with life soon after snowmelt or spring rains. Found across the U.S. and in many parts of the world, these ecosystems are dynamic and seasonal. As a pool dries, many of its animals migrate far into surrounding forests—if not obstructed by human development—and return the next year when the pool fills once more.

SMALL POOLS, BIG CONNECTIONS

Hundreds of species of animals, mostly migratory, can be found in vernal pools. Certain frogs, fairy shrimps, and salamanders largely depend on the pools for breeding.

- Life span
- Average number of eggs laid
- Typical adult migration distance
- Size



Fairy Shrimp*

- 50-90 days
- 100s
- None
- 0.5-1 inch

In the dry season, eggs lie dormant. Viable for years, the crustacean eggs hatch when pool waters return—and for a life span lasting only as long as the pool does.

Wood Frog

- 3-5 years
- 1,000
- 435 ft
- 2-3 in

Their bodies are adapted to partially freeze when hibernating under forest leaf litter. After waking, adults travel to pools to deposit egg masses that soon turn into tadpoles.

Spotted Salamander

- 15-20 years
- 20-100
- 390 ft
- 6-8 in

These amphibians emerge from upland burrows to deposit eggs on submerged stems. Eggs must develop from larvae to juveniles before the pool dries.

NORTHEASTERN U.S. VERNAL POOL



BREEDING ZONE

The seasonal forest pools host aquatic-breeding invertebrates, amphibians, mollusks, and crustaceans—all free from predation by fish.

FOREST REFUGE

Leaf litter and fallen trees on damp forest floors shelter amphibians and reptiles as they migrate to foraging and hibernating upland habitats.

WILDLIFE OASIS

Vernal pool waters and their concentrated assemblage of prey are a source of food, water, and resting sites for myriad forest animals.

CANOPY PROTECTION

Intact canopy cover helps retain the humid climate that frogs and salamanders, which have moist, permeable skin, require to survive.

DEVELOPMENT

Rainy-night, early spring migrations back to pools of their birth expose animals to vehicle strikes and deicing chemicals on roads.

POOL NETWORK

Most animals return to their natal pools, but some juveniles disperse to other waters, spreading their genes across a larger landscape.

*FAIRY SHRIMP (*EUBRANCHIPUS VERNALIS*), WOOD FROG (*RANA SYLVATICA*), AND SPOTTED SALAMANDER (*AMBYSTOMA MACULATUM*) RANGES SHOWN
 MONICA SERRANO, KATIE ARMSTRONG, PATRICIA HEALY, AND EVE CONANT, NGM STAFF. ART: KOMA ZHANG. SOURCES: ARAM J.K. CALHOUN AND MALCOLM (MAC) HUNTER, DEPARTMENT OF WILDLIFE, FISHERIES, AND CONSERVATION BIOLOGY, UNIVERSITY OF MAINE; IUCN; INATURALIST



Vernal pools are fleeting oases that many species depend on, including (clockwise, from top left) a juvenile painted turtle, a ringed bog haunter (a rare dragonfly), a barred owl, and a blue-spotted complex salamander, all

found in the Northeast. A portrait (opposite) reveals a wood frog during the breeding migration. Such species are a good indicator of a pool nearby, although they will travel up to thousands of feet to reach one.





A school of tadpoles swirls amid sphagnum, leaf litter, and fallen tree branches in a vernal pool in early spring. These swimmers feed on algae, bacteria, and more and can become food for other animals. As adults, most frogs will return to their birth pools to breed.

An aerial view shows a large vernal pool and the surrounding landscape in Aurora, Maine. The state has more forested area—nearly 90 percent of the land—than any other state in the country.



the females that the spring ritual has begun, and many hungry predators that have endured a long winter also hearken to the cacophony. This ritual, full of quacking, splashing, and shrieking as males struggle with one another to grasp females in a mating hold, is brief. The females expel round masses of eggs. The males, tight to their backs, release a cloud of sperm to fertilize them.

Spotted salamanders arrive at about the middle of the frog mating ritual. These members of the mole salamander family spend almost their entire lives below the surface of the land, under mosses and leaves and tree bark, in the tunnels left by long-dead roots, and within the decomposing trunks of fallen trees. Unlike the wood frog, the salamander overwinters below

the frost line, often in the deep burrows made by short-tailed shrews.

Their mating ritual is performed underwater, a mute congress of many, as the males place their white spermatophores, pyramid-shaped sperm packets, on a leaf or twig on the pool bottom. A female passes over them, enveloping one into her cloaca for fertilization. Their egg masses, attached to sticks and stems, are kidney-shaped, smooth, and somewhat translucent, encased in an outer layer of firm jelly.

As the salamander larvae grow, they feed on insects and small crustaceans and wood frog tadpoles, and each other. The tadpoles prey on amphibian eggs and carrion, but their diet is primarily algal and bacterial film they scrape

from the surfaces of plants and other pool detritus. Everyone is eating or being eaten, and most, but not all, are racing against the summer drawdown.

Nearly all mature wood frogs and spotted salamanders aim to return to their birth pools to breed, but a few juveniles are pilgrims. Each year a number will metamorphose, climb out of their pools, and walk away, carrying their genetic infusions to farther ponds on the forest floor.

VERNAL POOLS CONTINUE to be overlooked. Their best advocates are biologists who study them and people in towns and villages willing to make the case to protect them against development. A growing movement in the Northeast

brings local citizens out at night in the first spring rains to assist amphibians crossing busy roads to their natal pools. To cradle a salamander or a wood frog in the cup of your hand on a cold night is like holding a living icicle.

Some people take it upon themselves to map the pools, checking for species and making detailed notes of the surrounding landscapes. Those who do this work know that to save a pool without protecting its broad edges as well as its uplands is to save very little.

A persuasive voice in the effort to teach what is known about vernal pools and how to save them, Aram Calhoun dedicates her career to these reserves of temporary water. She is a seasoned wetlands biologist and environmental educator. Her writing has become part of wetlands landscape policy that resonates in Maine and beyond. Calhoun has also worked alongside biologists in the Department of Natural Resources of the Penobscot Nation to build a case for mapping vernal pools on tribal land.

“The Penobscot Nation Department of Natural Resources has just received five million dollars in funding from a public-private grant program to support work to map vernal pools on tribal trust lands,” says Ben Simpson, the wildlife resource manager for the nation. “These funds will help us map critical habitat the tribe is determined to protect.”

My neighbors and I learn from efforts such as these. Together we trudge out to our back road in the rains of April with flashlights and headlamps to greet frogs and salamanders making their slow way through the dark to the pools where they began. It’s a celebration of what it means to be alive, to share where we live with species other than our own. □

Photographer **Tristan Spinski** lives in Maine. This is his first feature for *National Geographic*.

