

a closer look

Impermanent Pools

MATTHEW BETTELHEIM

IT'S RAINING AGAIN. THE DROPS plink down hard, and the earthen dimples tucked between the rolling grasslands are filling fast. Here, at the vernal pools of Jepson Prairie Natural Reserve near Dixon, California just a stone's throw from Interstate 5, the first rains of the season mark the start of a race against time and drought. An invertebrate soup of animals is hurrying to hatch, feed, grow, and breed before the pools' waters vanish in a blaze of wildflowers beneath the summer sun.

This is just one of a series of vernal pools that line the eastern side of the Central Valley from Oregon to Baja. They are the footprints of glaciers that receded three to four million years ago at the end of the last Ice Age. Likened to snowflakes in their uniqueness and to islands in their isolation, vernal pools play host to a cast of flora and fauna that grows nowhere else.

Vernal pools differ from ponds and other wetlands in that they are temporary, a characteristic tied to the makeup of the underlying soil. A waterproof layer of vol-



Vernal pools burst into life with winter's first rain, providing critical habitat for hundreds of plants and animals. As pools dry, wildflowers such as native yellow goldfields erupt along the waters' edge in concentric rings. Eventually, all that remains to the eye is dried, fissured earth.

canic mud or hardpan clay seals the bottom of each basin, preventing rain from percolating into the ground. Neighboring pools are separated by upland grasslands and, on occasion, earthy humps of unknown origin known as "mima mounds." Sometimes pools are interconnected by vernal swales, small drainages that couple the depressions.

At the height of winter rains, vernal pools range in size from mere puddles to shallow lakes such as Jepson Prairie's Olcott Pool, which can be two feet deep and cover nearly 90 acres. In spring, concentric rings of gold, white, and purple wildflowers bloom around the shrinking pools. By summer's end, all that remains are brown bowls of stubbled, fissured soils.

Each pool is a universe unto itself, home to a combination of species tailored to cope with its specific size, chemistry, and the length of its wet season, regardless of its proximity to neighboring pools.

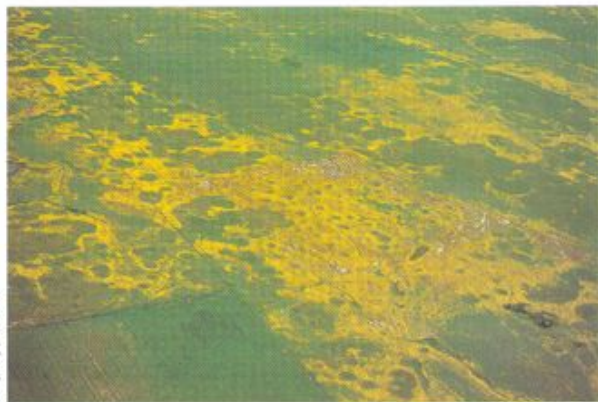
AFTER MILLENNIA of adapting to annual cycles of flood and

drought, most pool inhabitants have developed life cycle stages that include drought-resistant seeds, spores, or cysts. They can lie dormant in the earth for years until, awakened by moisture, they emerge to live their lives in fast-forward. At Jepson Prairie, winter's first rains have roused

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a subterranean minefield of eggs and seeds. Within days, inch-long Conservancy fairy shrimp (*Branchinecta conservatio*) scoot upside down through the water, furiously paddling their eleven swimming legs towards meals of suspended algae, bacteria, and protozoa. They are scrambling to mature, mate, and lay eggs during the few weeks before predatory insects arrive in spring. Its relative, the vernal pool tadpole shrimp (*Lepidurus packardii*), resembles its amphibian namesake as it zooms along the muddy basin bottom.

These crustaceans waste no time in attaining sexual maturity. They may reach adult form about a month from hatching. The time required to reach adulthood varies from species to species and pool to



Jepson Prairie Natural Reserve in Solano County, California. Dark green areas are still-moist pools, while yellow goldfields are flowering where pools are beginning to dry. Encroaching grazing and other human developments have destroyed up to 95 percent of the state's vernal pools.

pool, and may be related to water temperature or how long a particular pool lasts.

Tadpole and fairy shrimp take a clever approach to ensure their survival in pools that may stay wet for many months one year, then dry up within weeks the next. Cysts in each clutch are programmed to hatch under different conditions. Some will hatch after a single season of drying and getting wet again, while others bide their time for as many as 16 dry-wet cycles.

Amphibians take advantage of the opportune waters to breed and deposit their eggs. The California tiger salamander (*Ambystoma californiense*), a plump black sausage dappled with cream spots, emerges from the dark, moist confines of abandoned rodent burrows with the first rainfall. Roused from its summer torpor, the western spadefoot toad (*Scaphiopus hammondi*) awakens to croak in noisy choruses to find a mate. These toads can eat enough in one meal to last the rest of the year. After mating, they go right back to sleep, tunneling burrows up to three feet long where they will stay until next winter.

California's vernal pools are located



Western spadefoot toads rely on seasonal pools to mate and lay eggs. Before the waters dry, they dig up to three feet down into the soil, where they'll remain until the following year.

along the Pacific Flyway and serve as important rest stops for migratory waterfowl. Tundra swans and herons, stilts and avocets, depend on the pools' party-mix of crustaceans for sustenance on their long journeys. Meanwhile, microscopic seeds and eggs stick to their feet and feathers. When the birds go off to sample the buffet in a different pool, they help disperse these organisms to new frontiers.



Most plants in California vernal pools are endemic to the state, some found only in specific pools. This species of downingia at Jepson Prairie Reserve is found in a narrow strip from western Sacramento Valley to Monterey County.

As the weather warms, water in the pools begins to recede. Millions of new cysts, seeds, and eggs settle into the moist mud between the cracks in the drying crust. Plants trade winter's soft leaves for hairy summer foliage unpalatable to hungry herbivores. By March, vernal pool wildflowers erupt in concentric rainbow rings on the heels of abating waters. Buttery meadow foam (*Limnanthes douglasii*) and azure down-

ingias (*Downingia* spp.) bloom yellow and purple on the shores of each pool. Solitary bees in the genus *Andrena* specialize in pollinating only a single species of vernal pool meadow foam or downingia. And native goldfields (*Lasthenia* spp.), coyote-thistle (*Eryngium castrense*), and hairy orcutt grass (*Orcuttia pilosa*) wave in the distance.

Within weeks, these floral fairy rings succumb to the scorching summer heat. A five

o'clock shadow of stubble atop sun-baked mud is all that can be seen, but the pools' patrons, and their seeds and eggs remain hidden beneath the soil or in neighboring burrows, waiting for the cycle to make another turn.

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THE LAST FIVE PERCENT

THE INTIMATE RELATIONSHIP VERNAL POOLS have with their tenants may prove their Achilles' heel. More than 73 species of vernal pool plants and animals are listed as rare, including the California tiger salamander, vernal pool tadpole and fairy shrimps, and hairy orcutt grass.

The rock-hard volcanic soil that saved California's pools from the plow is now yielding to developers' bulldozers. All but about five percent of California's original pools have

already been lost. Until this year, the University of California planned to build an "environmental" campus, UC Merced, on 2,000 acres overlooking Lake Yosemite—a site that would have threatened more than 7,000 vernal pools. Criticism from environmentalists prompted officials to shift the location of the proposed campus. Scheduled to open in 2004, UC Merced will add close to 45,000 new residents to the valley—most of whom will need a nearby patch of land to call home.

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