

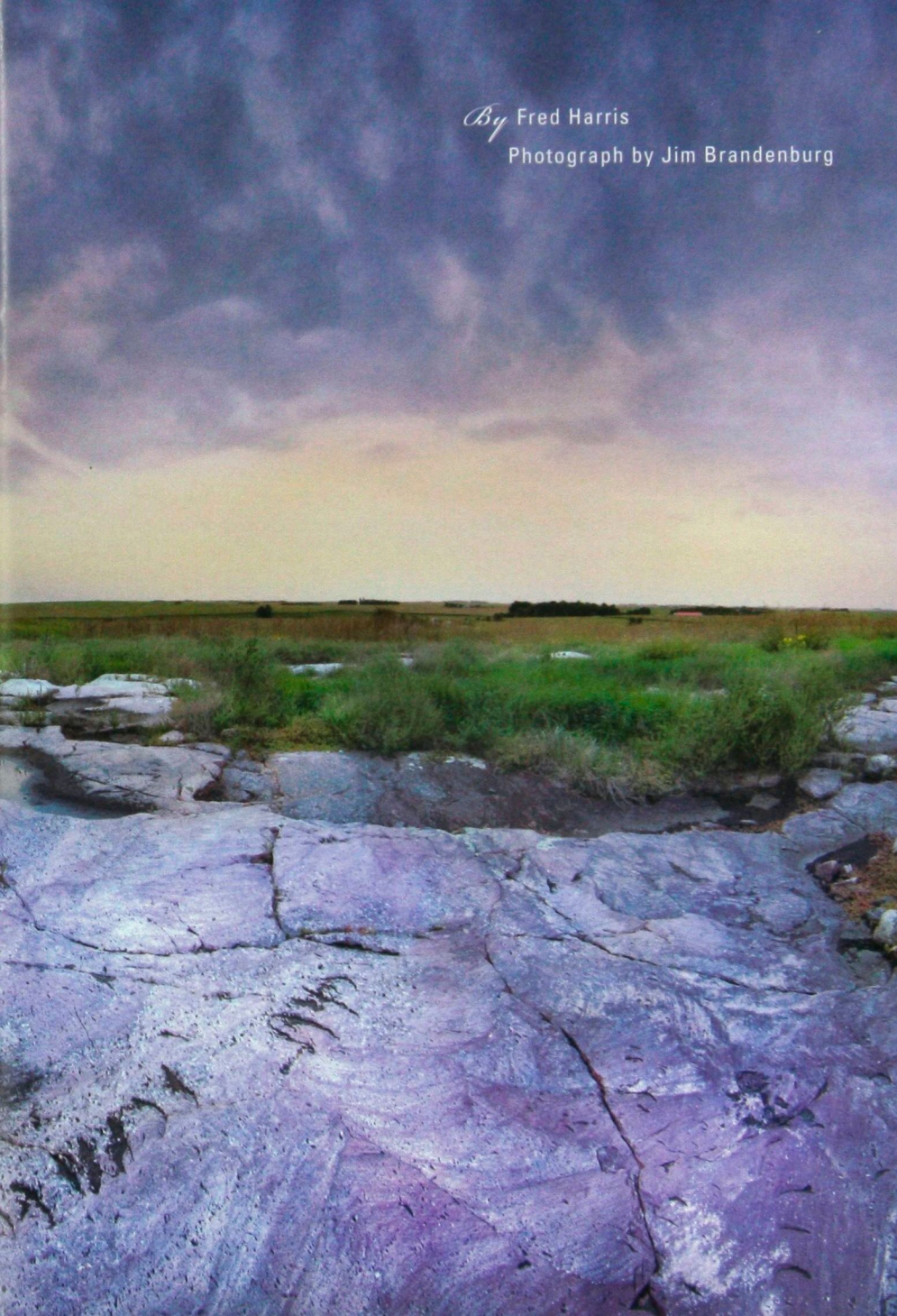
Rock Pools *on the Prairie*

They may seem little more
than puddles on rock outcrops, but these
ephemeral pools harbor
some of Minnesota's rarest plants.



By Fred Harris

Photograph by Jim Brandenburg



Gusts of wind blew rain in my face as I walked the length of a mile-long ridge in a treeless pasture in southwestern Minnesota. I sidestepped cascades of water pouring off ledges of deep reddish-pink Sioux quartzite and scanned crystal-clear pools in shallow depressions on exposed bedrock on the crest of the ridge.

As I neared the end of the ridge, I finally spotted the object of my search: a pool about 8 inches deep, packed with tiny lily pads in the shape of four-leaf clovers. These were hairy waterclovers (*Marsilea vestita*), aquatic ferns at the far eastern edge of their U.S. distribution. They hadn't been recorded in the region since 1946.

I was on my first visit to survey rare plants and native plant communities in Pipestone County; and despite the drenching, I was elated over this lucky start. This elusive fern might be visible for only one month, or not at all if spring rains aren't consistent enough to maintain the shallow pools where it lives. Tracking rare plants is part of my job as an ecologist for the DNR Minnesota County Biological Survey, a project to catalog what remains of rare species and native habitats across the state.

In Minnesota, several unusual plants are only seen in rainwater pools that exist for a few spring weeks on rock outcrops in the prairie before they vanish in the summer heat. Most Minnesotans don't even realize these mini-ecosystems exist. Now land-use changes are threatening many of these tiny rock pools on the prairie.

On Ancient Rock

Before European settlers tilled the land,

southwestern Minnesota was almost completely covered by native prairie. Much of this former prairie is now cropland, but exposed bedrock outcrops in two discrete regions—each with very different rock types and origins—shelter small areas of unique native prairie plant communities.

In the upper Minnesota River valley from New Ulm to Ortonville is a long, linear zone of low, rounded gneiss and granite knobs. Following the retreat of the last glaciers some 12,000 years ago, the massive erosional forces of Glacial River Warren—which catastrophically drained Glacial Lake Agassiz between about 10,800 to 9,400 years ago—exposed and abraded this ancient bedrock. Some of these outcrops date to 3.5 billion years of age, nearly a billion years older than the bedrock visible in the Boundary Waters Canoe Area Wilderness.

Farther southwest, in the corner of the state, broad ridges of reddish-pink Sioux quartzite reach the surface in portions of the uplands known as the Coteau des Prairies, or Prairie Coteau. Originating as river and marine sand transformed by heat and pressure, this 1.7 billion-year-old quartzite is much younger than the Minnesota River valley bedrock. The corners of some large quartzite boulders are

polished to a glassy sheen, perhaps rubbed by bison that roamed the landscape for thousands of years. Geologist Carrie Jennings of the Minnesota Geological Survey thinks the polishing resulted mainly from hundreds of thousands of years of perpetual blasting by sand grains in the winds. With “cosmogenic dating,” she and her colleagues estimate that the western portion of the Sioux quartzite region has been free of glacial ice and exposed to the elements for 400,000 to 600,000 years. This history stands in remarkable contrast to much of the rest of the state, which was actively being buried under glacial deposits as recently as 14,000 years ago.

In bedrock regions, shallow soils over rock retain little moisture for plant growth, especially in midsummer heat. But drought-adapted plants thrive in these soils. They include Minnesota’s three species of cacti (*Opuntia macrorhiza*, *Opuntia fragilis*, and *Coryphantha vivipara*) and the succulent, small-flowered fameflower (*Talinum parviflorum*), known for its brilliant pink flowers that open briefly in early June evenings.

In the spring, shallow depressions on the bedrock surface accumulate rainwater, forming ephemeral, or *vernal*, pools. These seasonal pools support a surprising diversity of aquatic plants. Only a few pools on any one outcrop are the perfect depth for ephemeral pool specialists—deep enough to last a few weeks but not so deep that permanent wetland vegetation can take over.



Top: Water cascades off a Sioux quartzite ridge during heavy spring rains in 2008. **Bottom:** Depressions in rock outcrops, like these on private land in Rock County, fill with water in early May and last for only a month.



Many ephemeral-pool species exist as submerged aquatic plants that will not flower until they are stranded in moist mud after the pools evaporate. Once stranded, they morph into upright plants with more rigid leaves that last for a couple of weeks. The plants vanish as the sun bakes the mud into cracked crusts of sediment.

Minuscule Rarities

Minnesota has about 15 rare plant species limited to bedrock pools. These small plants with bland names lack the stature of white pine, the head-turning beauty of prairie phlox, or the allure of northern moose. Nevertheless, some of them are among the rarest species in Minnesota. Several of these species, or close relatives, are renowned among botanists for inhabiting vernal pools across the world in places such as California, Georgia, western Australia, South Africa, and high plateaus in the Andes Mountains of South America.

We have found just 20 locations in Minnesota of the water hyssop (*Bacopa rotundifolia*), a tiny plant with floating, dime-sized leaves and small white flowers. Each population typically consists of hundreds of plants packed into one or two small pools per outcrop. For unknown reasons water hyssop appears to be more common on the Minnesota River valley outcrops than anywhere else in the state.

On a few of my plant surveys in southwestern Minnesota's bedrock pools, I

Top: The leaves of a hairy waterclover, an aquatic fern, float on a rainwater pool. Bottom: One of Minnesota's three species of cactus, brittle prickly pear grows on the margins of rock outcrops.

have found a couple of rare species really by accident, as I had no idea what to look for. Near the end of spring in 2007, I stumbled on what appeared to be a minuscule seedling in drying mud. I had to use a microscope to see what turned out to be a fully mature pigmyweed (*Crassula aquatica*), an unusual example of a succulent aquatic plant.

Most succulent plants, like cacti, grow in very arid environments like the desert, where they take up carbon dioxide at night and store it in their fleshy leaves so they can shut down during hot, dry days and minimize evapotranspiration. Likewise, pigmyweeds take in carbon dioxide at night, albeit in a watery rock pool. And they do so for a completely different reason than cacti: By collecting carbon dioxide at night, pigmyweeds don't have to compete for limited carbon dioxide with other aquatic plants during the day in the nutrient-scarce tiny rock pools.

When stranded in mud, the pigmyweed reaches a maximum height of 1 inch, complete with four-petaled, pink flowers the size of Lincoln's nose on a penny. The plant is so easily overlooked that it had been recorded only once in southwestern Minnesota (in 1945) prior to its initial rediscovery and five subsequent new populations, which an assistant and I located in 2008.

For me, the holy grail of outcrop plants is mud plantain (*Heteranthera limosa*). With a deep-blue flower the size of a quarter, it is the largest and showiest of



Top: Prior to 2007, pigmyweed had not been documented in Minnesota since 1945. Bottom: The state's largest population of pigmyweed flowers persists in the drying mud at the edge of an outcrop at Blue Mounds State Park.

our ephemeral-pool specialists, but only three living botanists have ever seen it in Minnesota (including me when I saw it flowering once). Mud plantain takes longer to mature than other pool specialists, and thus requires longer-lasting pools (six to seven weeks instead of the more typical three to four weeks). Most seedlings die from lack of moisture before they can mature.

The dynamic nature of bedrock pools and the plants' responses pose an interesting but also frustrating challenge. More than once I've found rare plants and then returned two weeks later with a group of enthusiastic plant lovers only to find dried-up, fading blobs in cracked mud, or plants buried in sediments after heavy rains washed soil into the pools. On a few serendipitous occasions, however, I have encountered a dozen of these rare species all growing together at the same time.

Outcrop Critters

Minnesota's rock outcrops have some characteristic animal inhabitants. Tiny fairy shrimp and clam shrimp, frequently seen zipping around in rainwater pools, can survive through the prolonged dry periods as cysts that hatch soon after the pools fill with water in spring. They thrive in the absence of predators such as fish, dragonfly larvae, and diving beetles.

The five-lined skink (*Eumeces fasciatus*) lives on rock outcrops in three widely separated areas of Minnesota, including outcrops near Granite Falls. They also live in two counties in southeastern Minnesota and one in east-central Minnesota. This lizard is distinguished from the similar prairie

skink by the forked stripe, or V, atop its head. The five-lined young have bright blue tails, thus the nickname "blue devils."

Skinks are active from May through August and then hibernate for eight months below the frost line in bedrock cracks or small mammal burrows. If you turn over loose rocks on a Minnesota River outcrop, you might send a skink skittering across the bedrock.

Occasionally, while scanning outcrop surfaces for tiny plants, I have been jolted by the sudden flush of a common night-hawk (*Chordeiles minor*), disturbed from incubating its eggs deposited directly on the bedrock surface. Both birds and eggs are mottled to blend in with the surrounding pitted and lichen-studded rock.

Rocky Future?

Though rock solid, outcrops are vulnerable to habitat destruction, especially in pastures in southwestern Minnesota. There, many pastures undergo heavy broadleaf herbicide applications for thistle control, which can also destroy native wildflowers. Overgrazing is another problem because densely packed cows churn up the shallow soils and pools on rock outcrops. And a new threat, recently witnessed in Rock County, is the conversion of rocky pastures into cornfields by excavating the bedrock.

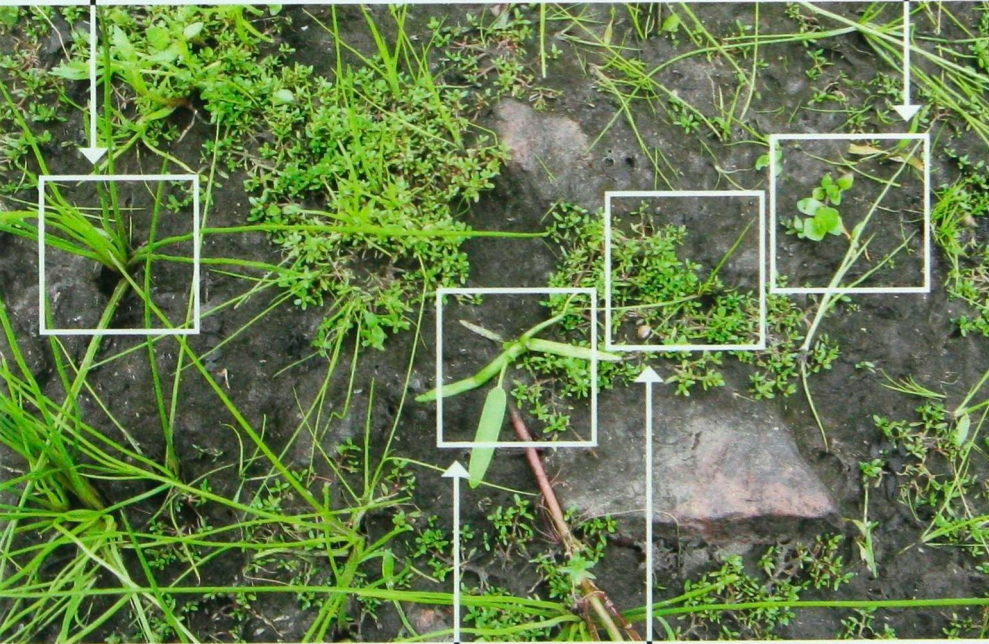
Some landowners are striving to sustain the native plant diversity in their pastures. At the end of a long quartzite ridge, a few miles south of Jasper, is Richard Bakken's farm. A series of reddish-pink rock ledges thrusts out from a landscape of tall prairie grasses and wildflowers. When he purchased this pasture 15 years



Top: Water hyssop (left) and mudwort (*Limosella aquatica*) (right) thrive when rock pools are full in mid-May. Bottom: A single rock outcrop pool occasionally holds several rare aquatic species. At Blue Mounds State Park, black-footed quillwort, mud plantain, three-stamened waterwort, and water hyssop are stranded in the mud of a drying pool. These plants persist two to three weeks after the pools dry.

Black-footed quillwort
(*Isoetes melanopoda*)

Water hyssop
(*Bacopa rotundifolia*)



Mud plantain
(*Heteranthera limosa*)

Three-stamened waterwort
(*Elatine triandra*)

ago, Bakken says this area “looked like a bombed desert” because of the previous landowner’s aerial applications of herbicide to every living thing.

With judicious management, including carefully timed grazing, Bakken sees the native grasses, forbs, and small oak groves are rebounding. In spring, numerous rock pools harbor a variety of specialist plants, including most of the region’s rare rock-pool species. Better pasture management makes economic sense too, yielding bigger, healthier calves. Bakken is also proud that he can sometimes spot the long ears of jackrabbits bobbing through the tall grass, a scene from his youth that today is all too uncommon.

Over the past decade, many landowners are being tempted to open up their rock outcrops to mining, fueled by federal highway construction standards now requiring crushed bedrock instead of gravel. In the scenic Minnesota River valley, permanent

alterations to the landscape from mining have alarmed many local citizens and communities. In response, the Renville County Soil and Water Conservation District coordinated a recent outcrop conservation initiative, funded through the Minnesota Environment and Natural Resources Trust Fund. Interested landowners in Renville and Redwood counties were compensated for the financial value of their rock outcrops in exchange for easements to permanently protect the most ecologically intact outcrops. Landowners responded with applications for 10 times the number of acres that funds allowed. As a result, additional money is being recommended for easements on granite outcrops in Renville and Redwood counties, as well as adjacent Lac qui Parle, Yellow Medicine, and Chippewa counties.

Bedrock mining clearly needs to continue somewhere in the region to supply highway rock. Landowners, communities, and state

Where to Find *Bedrock Pools*



Top: Bracted spiderwort is a prairie wildflower commonly seen on the margins of rock outcrops. Bottom: During summer five-lined skinks, one of three species of lizards in Minnesota, can be seen basking on rock outcrops.




and local governments must decide where to protect rare features and where to permit mining. By identifying which outcrop areas are the most ecologically intact and diverse, the Minnesota County Biological Survey is providing crucial information for their decision making.

Wishing for a Wet Spring

Tom Kalahar, district technician for the Renville County SWCD, likens the fate of southwestern Minnesota's rock outcrops to an earlier era of habitat destruction in the prairie region. "Think of what it must have been like early in the last century to witness the draining of the wetlands and the loss of breeding habitat for massive numbers of ducks and other wildlife," he says.

Like wetlands, bedrock pools reveal a surprising diversity of life to anyone who looks closely at them. These unique and secretive environments in our state's southwest are yet another amazing component of our rich Minnesota heritage. I'll be back out there again this spring, looking for plants that can't be found anywhere else. I'll take it as a good sign if I get soaked in the rain, as a good wet spring means thriving pools bursting with life. And maybe I'll find that holy grail—the mud plantain—again. **V**

 www.mndnr.gov/magazine See more images of Minnesota's rock outcrops and the unique aquatic plant life of their rainwater pools.

