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THE SONORAN QUARTERLY

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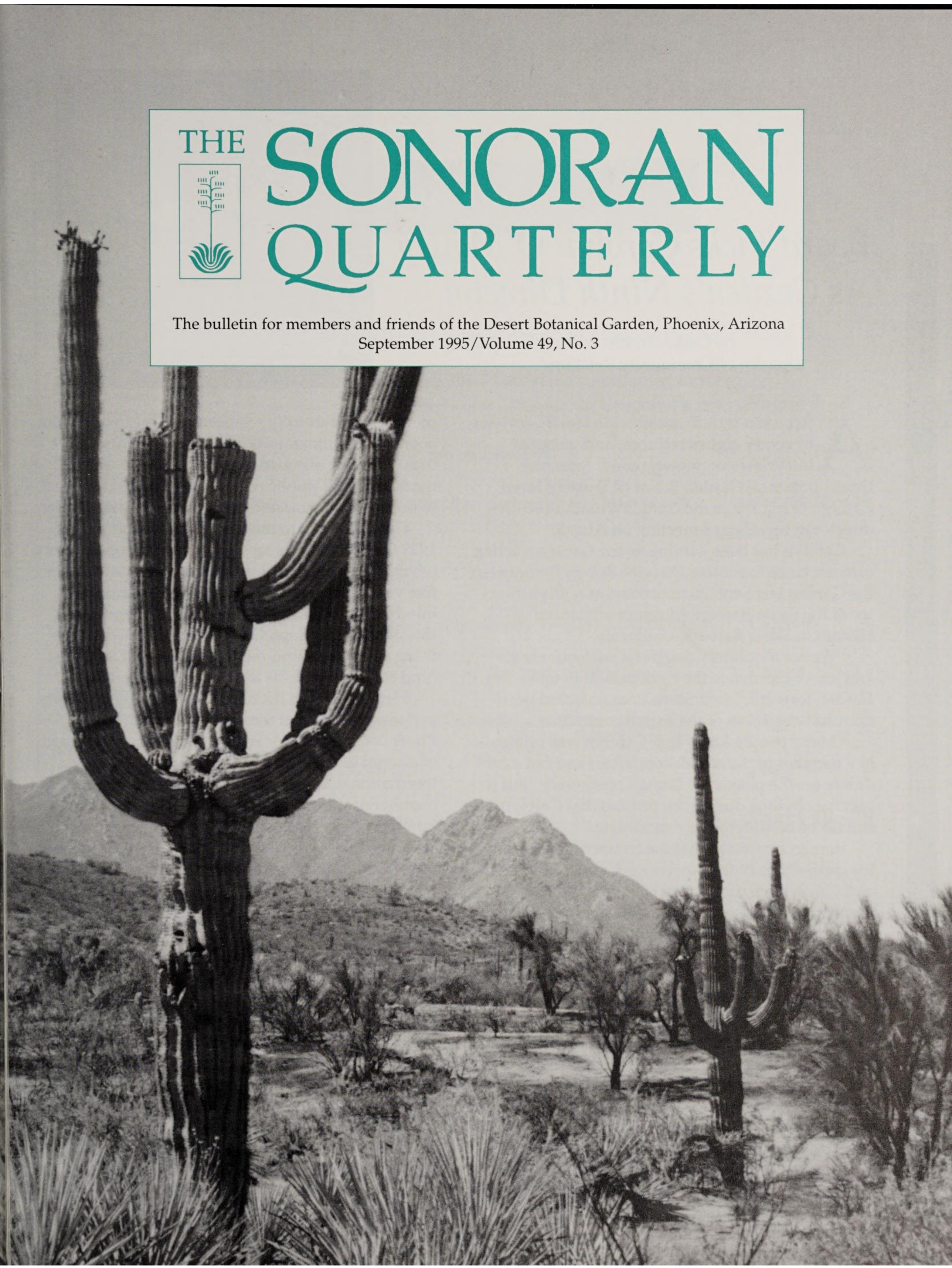


The Aftermath of Wildfire in the Sonoran Desert

In the McDowell Mountains northeast of Phoenix, a wildfire ignited by lightning raged for four continuous days in early July. The blaze, named the "Rio" fire, eventually blackened thirty-five square miles. Although many had predicted widespread fires this year in the Sonoran Desert, the size of this conflagration, which incinerated a large part of McDowell Mountain Park, was a terrible shock. Newspaper and television reports conveyed the public's deep sense of loss for the scenic palo verde- and saguaro-studded landscapes.

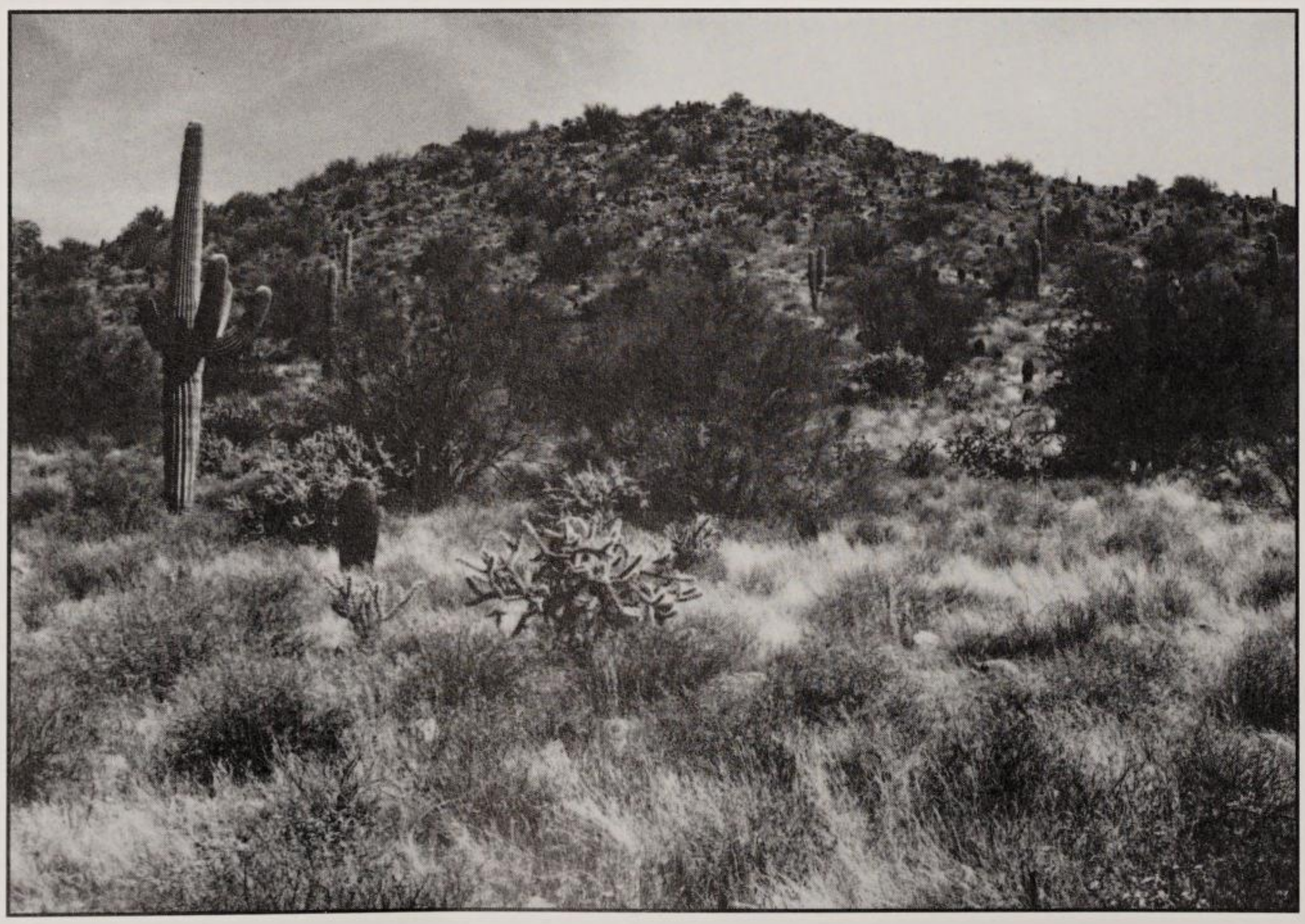
Many questions have been asked about the causes and ecological impacts of this fire. This article discusses the factors that are increasingly supporting large fires, the immediate effects of these fires, the short- and long-term ecological changes that follow, and an outlook regarding the potential future impacts of wildfires in the Sonoran Desert.

Causes of desert fires

Large gaps of plant-free space ordinarily separate canopies of trees and shrubs in the Sonoran Desert. This wide separation of pockets of potential fuel makes the unchecked spread of wildfire extremely unlikely. That changes radically, however, when unusually wet winters produce lush growth of ephemeral (short-lived, lasting only for a few days or a season) plants in the gaps between trees and shrubs. Subsequently, when the hot, arid summer arrives, this contiguous cover of dry, fine fuels can carry wildfire swiftly and catastrophically across the face of the desert, consuming the perennial vegetation in the process.

Analysis of almost thirty years of wildfires in the Sonoran Desert portion of Tonto National Forest has shown that the risk of fire is even greater following two consecutive unusually wet winter seasons. A bumper crop of seed produced by ephemerals during the first wet winter contributes to an even larger crop of ephemerals if the following winter season is also unusually wet. Weatherwise, three of the past four years have been the unusual "El Nino" years in which winter precipitation far exceeded the norm. These uncommon conditions are probably a major factor contributing to the more numerous and larger fires this year in the Sonoran Desert.

Although these moist climatic conditions are unusual, they certainly are natural. However, our human presence has in this century wrought a major ecological change within the Sonoran Desert that is producing larger and more destructive fires.



Story and photos by Dr. Joseph R. McAuliffe

In a wet year, red brome (light-colored patches) fills up otherwise bare areas between widely spaced shrubs. This hillslope east of Apache Junction was photographed in October 1993, and burned the following year.

Red brome is a non-native, ephemeral grass introduced from the Old World.

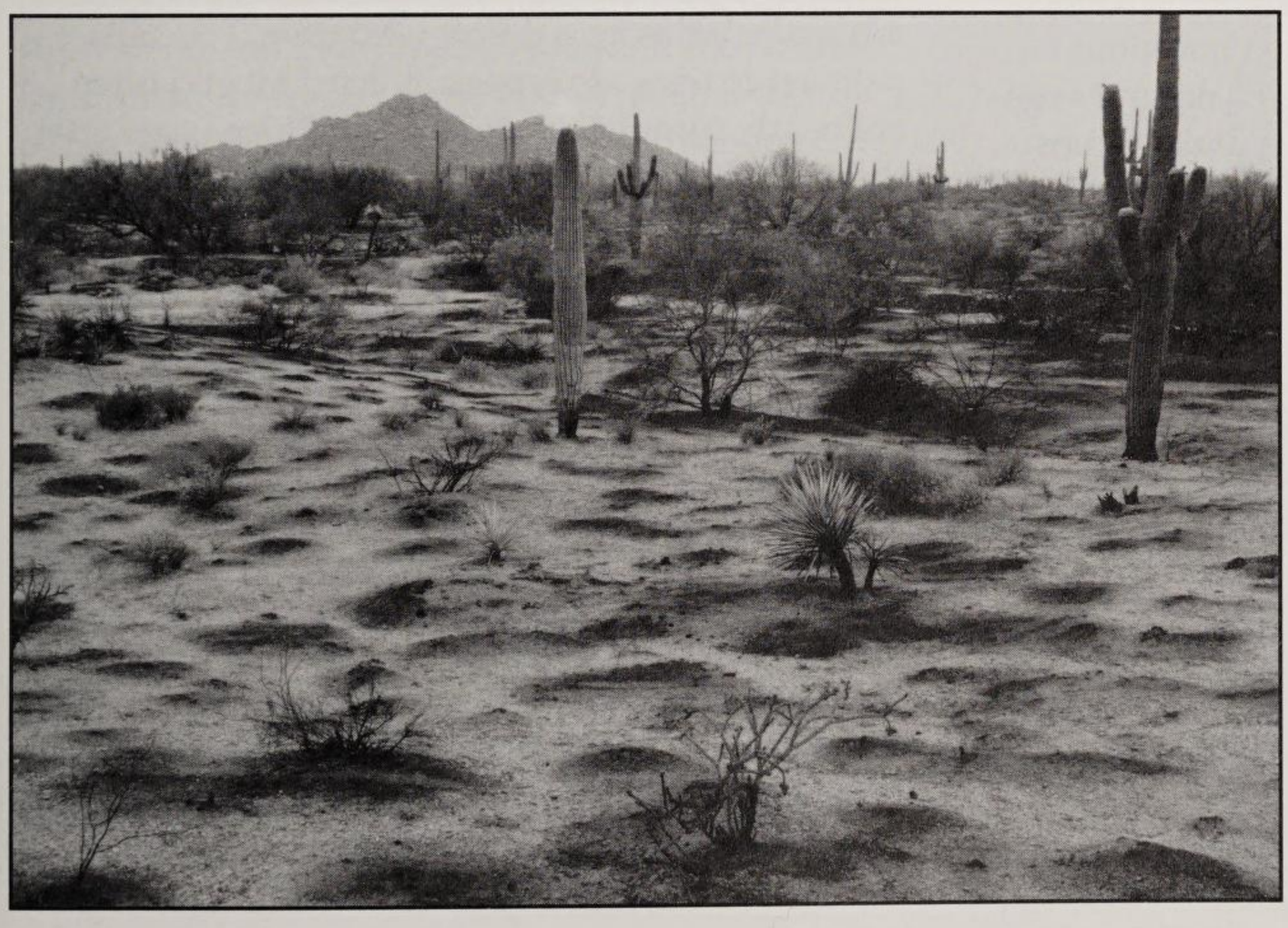
This change is the widespread invasion of the southwestern deserts by red brome (sometimes called foxtail brome).

A winter-active, ephemeral grass, red brome (*Bromus rubens*) is not native to the Sonoran Desert but was introduced from the Mediterranean region, probably in shipments of grain seed from the Old World. It was first documented in this country in California in 1848. Between 1906 and 1908 it was intentionally sown in desert grassland areas of the Santa Rita Mountains south of Tucson. In the last several decades red brome has become widespread and extremely abundant in the Sonoran Desert, and has today become the dominant winter ephemeral plant in many areas of the desert, displacing many native ephemerals.

In early July I examined some stands dominated by palo verde, saguaro, and bursage. I was surprised and dismayed at the degree to which red brome predominated at the expense of native ephemerals. In many areas a square meter in size, more than a thousand red brome plants were present, but at most only a few small individuals of native ephemeral species such as Indian-wheat (*Plantago insularis*), fiddleneck (*Amsinckia* sp.), and phacelia (*Phacelia* sp.) could be found. Some large areas contained *only* red brome. The production of plant matter by red brome outweighed production by native ephemeral plants by far more than a factor of 1000 to 1.

Without a doubt, this ecological invasion is dramatically altering the character of the winter ephemeral flora. Unfortunately, red brome also has the capacity to alter the perennial vegetation by increasing its vulnerability to summer fire.

Dry red brome seems much more fire-prone than the dried remains of most native ephemerals. Perhaps this greater flammability is due to the architecture of red brome plants. The dead, dry stems and seedheads of this grass remain erect like thin shafts of wheat straw. A dense stand of these



This area north of Scottsdale along Pima Road burned in early summer. Black patches mark places where small shrubs, primarily triangleleaf bursage, once grew.

closely-spaced, erect stems provides a dangerous incendiary medium.

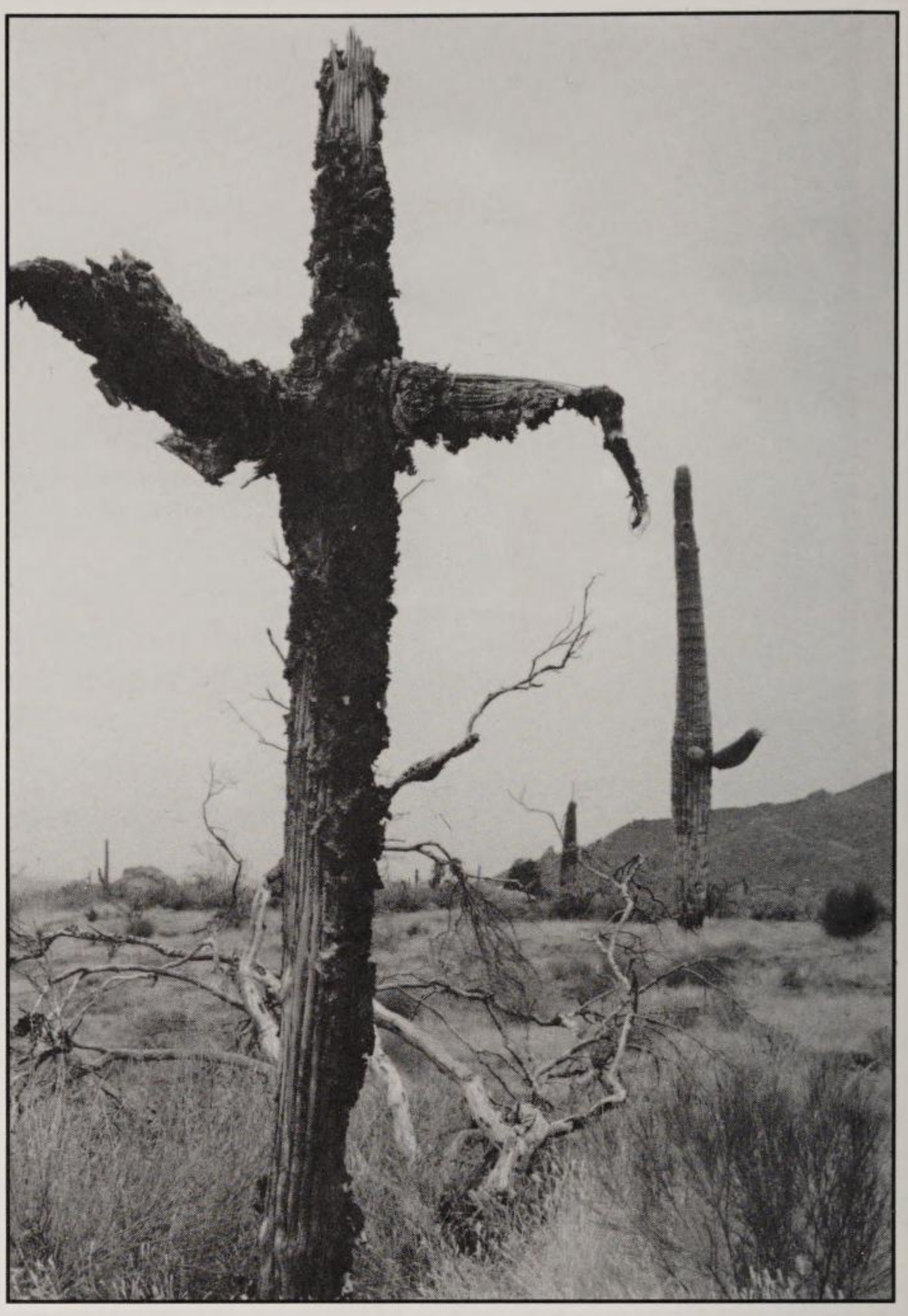
Even the smell given off by dry red brome reminds me of dry, highly flammable wheat straw. When I was observing the past spring's production of red brome in desert areas north of Phoenix, walking through dense, parched patches of red brome really made me nervous. I knew that for miles around the slightest spark or a carelessly tossed cigarette could set the whole landscape ablaze while I was knee-deep in all that fuel. With a bit of wind, a wildfire can race across the desert much faster than I can run.

Impact of fire, and short-term ecological responses

The dry, highly combustible stems of red brome, other ephemeral plants, and small twigs of low-lying shrubs burn quickly. Consequently, fires rapidly move across the landscape. The heat generated by such a fire usually kills the above-ground portions of trees, shrubs, and smaller cacti. What remains is a charred and denuded landscape. Once-green trunks of palo verde trees and saguaros are seared brown by the heat and small shrubs are reduced to polka-dot smudges of ash on the soil surface. The immediate aftermath of a wildfire in the Sonoran Desert is not a pretty sight.

One of the most frequently asked questions is, "How long will it take for the desert's natural vegetation to recover after a fire?" Unfortunately, most Sonoran Desert perennial plants are killed by fire and do not resprout from underground parts. This inability to resprout contrasts strongly with the response of perennial plants of ecosystems where fire has long been a part of the natural order. For example, in the chaparral of southern California, periodic fires completely incinerate the shrub cover on hillslopes. However, the intact root systems of these shrubs quickly resprout, and the vegetation is largely replaced by the original occupants. The inability of most Sonoran Desert plants to resprout after a fire indicates that fires have not been a significant factor in the evolutionary history of the Sonoran Desert flora.

Plants that fare extremely poorly after a fire are



The skeleton is what remains of a saguaro killed in 1992 in the Black Mountain burn. The photo, taken in July 1995, shows the return of some ephemerals, including red brome.

the very species that give the Arizona Upland part of the Sonoran Desert its unique character as an arborescent desert, a desert with trees. Foothills palo verde trees are especially hard hit and often are nearly completely eliminated. Three years after the 1992 "Black Mountain" fire near the town of Carefree, I surveyed one hundred palo verde trees, examining them for signs of regeneration. Only one top-killed tree had produced two living sprouts from a root exposed along a shallow wash. All the remaining palo verdes were completely dead and showed no signs of any resprouting.

Research conducted by others has also shown foothills palo verde trees to be extremely sensitive to fire. A fire apparently does not have to be particularly intense to kill a palo verde. The living, green photosynthetic bark of this tree is rather thin—about three to four millimeters thick. The heat of even small fires sears and kills the green bark and underlying cambium, causing death of the tree.

(The cambium layer produces the cells which become the inner wood and outer bark). The ironwood tree, with darker, thicker, non-photosynthetic bark survives much better in the aftermath of a fire.

Other perennial plants fare nearly as poorly after a fire as the palo verde. Typically only a few percent of triangleleaf bursage (*Ambrosia deltoidea*) plants resprout after being reduced to small piles of ash. Creosote bush (*Larrea tridentata)* is not as severely damaged, and I have seen areas where about half of the creosote bushes eventually resprouted after a fire. Small cacti such as pincushions, hedgehogs, prickly-pears, and all species of cholla are usually killed outright and do not resprout.

Survival of the saguaro depends on the intensity of the fire and the size of the plant. I have observed sides of tall saguaros seared by flames to heights of well over five to six meters (sixteen to twenty feet). Where fires are extremely intense, even tall, many-branched saguaros can be mortally damaged. Most young saguaros shorter than head-height are killed. Long-term studies have estimated that within a few years after a fire, as many as eighty-five percent of all saguaros may die.

Although palo verdes, bursages, saguaros, and other cacti are hit especially hard by fires, there are a few perennial plant species found in the Sonoran Desert that do resprout vigorously, even if the top of the plant is completely incinerated. Among the shrubs, nearly all catclaw and whitethorn acacias and fairy dusters (*Calliandra eriophylla*) resprout vigorously. The banana yucca (*Yucca baccata)*, found in areas around the McDowell Mountains also rapidly sends up new shoots. I have observed resprouting of all these species within as little as one month following fires.

Interestingly, these plant species that readily resprout after fire grow not only in the Sonoran Desert, but are also found in semi-arid grasslands where fires have long been a natural part of the environmental regime.

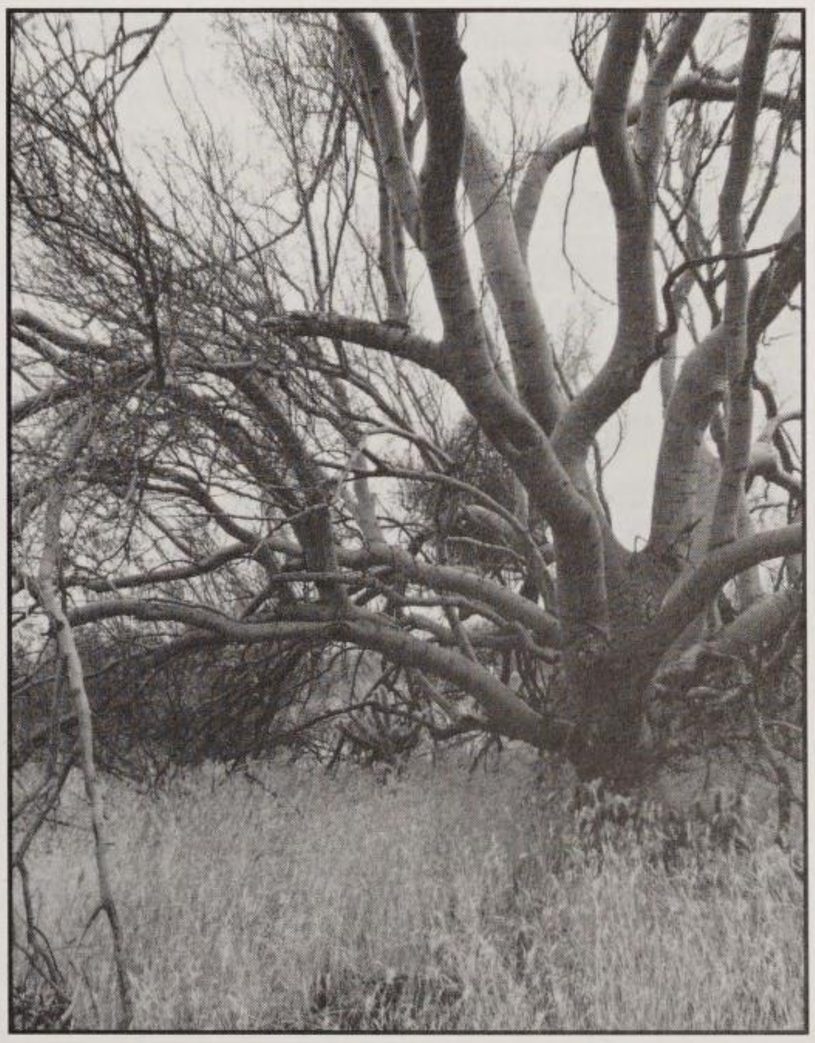
The numbers of plants capable of vigorously resprouting after a fire, however, usually constitute a small fraction of all the plants burned. Populations of most perennial plants are catastrophically reduced or even nearly eliminated. What is left in a fire's aftermath is a virtually ecological vacuum.

Regrowth of many desert perennials from seeds is very slow, requiring the presence of seeds as well as exact conditions suitable for germination and early survival. Even if seeds rapidly germinate and new, young plants establish, long-lived plants like saguaros and palo verdes require at least a century to reach large adult size. Consequently, burned areas of the Sonoran Desert will need at least another century's time to regain their original pre-burn character.

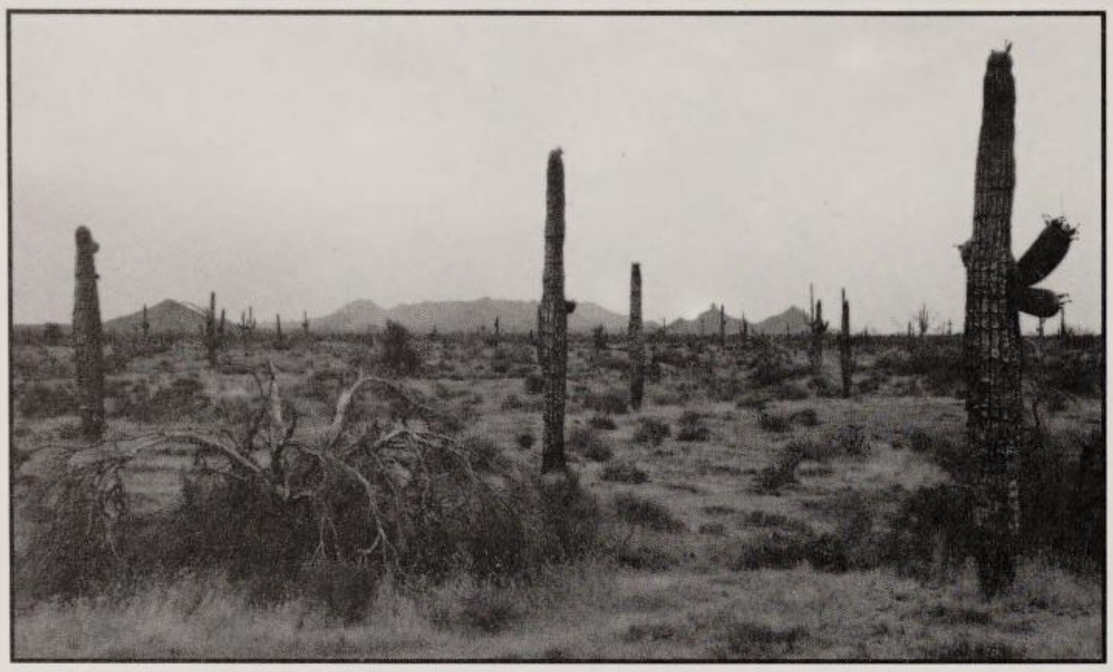
Long-term biological changes

In the years following a fire in the Sonoran Desert, different kinds of plants than those originally present take advantage of the ecological void created by the fire. One potential change is a shift in dominance from fire-intolerant species, such as the palo verde, to species that resprout vigorously after fire. For example, many areas that have burned in past decades now have an abundance of large catclaw acacias, but palo verdes are rare or absent where they otherwise would be expected.

Such a vegetation change is reinforced if an area



Red brome has sprouted and grown densely around this palo verde tree, increasing the fire risk for the Sonoran Desert native.



This view of the Black Mountain burn near Carefree was taken three years after the 1992 fire. The heat seared saguaros to more than ten feet in height and killed all palo verdes. At least a century without additional fires will be necessary for this area to regain the original grandeur of palo verde- and saguaro-studded landscape.

repeatedly experiences fire, essentially eliminating fire-intolerant species. This situation exists along some Arizona highways where frequent, man-started blazes have eliminated palo verdes and saguaros in swaths beside the roadways.

Another change that occurs in the years immediately following a burn is rapid colonization by certain short-lived shrub species that are rarely, if ever, encountered in intact, undisturbed desert areas. Within a year after the Black Mountain burn near Carefree, short-lived shrubs including wire lettuce *(Stephanomeria exigua)*, broom snakeweed (*Gutierrezia sarothrae*), and desert broom (*Baccharis sarothroides*) colonized the site and still persist. Each of these species has wind-dispersed seeds that facilitate long-distance transport and colonization of burned areas. These short-lived shrub species probably will persist until longer-lived but more slowly establishing shrubs such as bursage again start to predominate.

Marked changes also occur in the ephemeral flora after a fire. Interestingly, fires apparently consume the majority of red brome seeds and in the year immediately following a fire, red brome is typically uncommon. With the nutrients released from burned vegetation and the greater availability of water (since potential competition from perennials has been largely removed), native desert ephemeral wildflowers grow in profusion.

However, the setback for red brome is temporary. Within a few years, red brome gradually increases until once again it becomes the predominant ephemeral which produces all that unwanted, relatively persistent fire fuel. So, although a fire may temporarily remove red brome from the ecological picture, in the long run this problem grass is unfortunately here to stay.

Wildfires and the future of the Sonoran Desert

The largest, most destructive wildfires to date in the Sonoran Desert of Arizona have occurred almost exclusively in the Arizona Upland which forms a band averaging thirty to sixty miles wide at the northern and eastern desert margins. The "Rio" blaze and the even larger "Granite" fire which burned forty-four square miles in 1979 southeast of Florence were both in this most lush vegetation zone. Unfortunately, this zone at greatest risk contains the most species-rich and scenic environments inhabited by palo verde and awe-inspiring stands of saguaros.

Red brome is not the only non-native invader that may cause increased fires in the Arizona Upland in years to come. Buffelgrass (*Cenchrus ciliaris*), a tough, summer-active perennial grass from South Africa, has also become naturalized and is increasing in parts of the Sonoran Desert in Mexico and Arizona around Tucson. It also has the capacity to carry catastrophic fires during the dry season and even resprouts vigorously after a fire. By potentially supporting recurrent fires, red brome and buffel grass together have the capacity to deliver a knockout double punch to some portions of native vegetation of the Arizona Upland.

These ecological changes are due to our very presence in the Sonoran Desert. Areas burned by the "Rio" and other fires provide us with a perspective of how fragile the Sonoran Desert can be. We see the destruction left after a fire and understand that for the most part these fires are not a "natural" part of the ecological picture. Yet the kinds of changes these fires have set in motion make us more aware of how we must cherish and protect parts of the Sonoran Desert. This protection is deserved for desert areas slowly recovering from a wildfire as well as those containing magnificent stands of palo verdes and saguaros that have never felt the sting of fire. ◊

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