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Fire in the Sky

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Why America's ecological treasures sometimes just need to burn

by Jeff Wheelwright

The temperature at the base of the mountain was 100 degrees, not unusual for June in Arizona, but hail began to fall in the tiny wetlands called Bear Wallow Spring, at an elevation of 10,500 feet, on the tallest of the sky islands.

The white granulation fell straight down, caroming from the lush green stalks of the corn lily plants, bending the blossoms of the Franciscan bluebells. No trees interrupted the hail because the forest canopy had been incinerated the summer before. Just spruce trunks with peeling bark stood in the circle of the wet, while all around the oasis, the ground was black, and the woods were splintered and charred. Soon the decapitated trees would tip over.

The fire had burned so hot that it had bleached and split the rocks and strewed their fragments like seashells on black sand. Nothing was alive but spiders—everywhere spiders hauling their egg cases in and out of holes in the ashes. Yet within the magical ring of Bear Wallow Spring (magical to the Apache who used to drink here), hip-high spruce and fir prepared to recolonize the peak of this sky island.

The Nuttall fire rages atop Mount Graham in Arizona on July 6, 2004, threatening the 100-foot-high fire towers of Heligraph Lookout.

Sky islands is the popular term for a dozen disconnected mountain ranges in southeastern Arizona. A few of the ranges spill over into New Mexico, and others are located south of the border. Ecologists refer to the archipelago of mountains as the Madrean Archipelago; the U.S. Forest Service knows them as parts of the Coronado National Forest. Arising from the Sonoran Desert, the cactus sea that links them, each range has its own biological personality. But they all burn by the same rules.

Physical separation has caused their flora and fauna to diverge. Like the finches observed by Darwin in the Galápagos Islands, genetically distinct subspecies of squirrels, lizards, ants, and lichens have evolved on different outposts. Other differences are due to latitude. For instance, the crest of the Pinaleno range, where the 2004 fire occurred, hosts Engelmann spruce and cork-bark fir, a combination found also in Alaska. The trees are a relic population from the Ice Age. You won't find cork-bark fir at the top of the Chiricahua Mountains, 50 miles farther south. Conversely, neotropical hummingbirds and Apache pines, to name some Chiricahua species, aren't seen in the Pinalenos. Large animals like black bears, cougars, and bighorn sheep used to migrate between the mountain ranges, but human development has cut off their corridors and reinforced each range's biological isolation. As a result, most of the natural action in the sky islands takes place in the vertical dimension, including the action of wildfires.

As islands they seem remote, not because they're far away but because they're far above. Climbing them, you start in Mexico and end up in Canada, each 1,000-foot gain in elevation the ecological equivalent of a 500-mile trip north. The mountains pack more environments into a shorter vertical distance than any terrain in the United States. On the ranges with roads, like the Pinalenos, the Chiricahuas, and the Santa Catalinas, a botanical and meteorologic inventory of western North America can be completed in a half hour.

"Up here you can dial up any kind of weather at any time," said David Hodges, as he brushed hail from his jacket at Bear Wallow Spring. Hodges works for the Sky Island Alliance, a Tucson-based environmental group. "The high elevations are magnets for monsoon storms," he added. Monsoonal rain in Arizona occurs in midsummer, when south winds draw moisture from the Gulf of Mexico and fling thunderheads and lightning against the rims of the sky islands.

Hodges led the way up a crunchy slope still smelling of smoke to an overlook called Hawk Peak. As if on cue, a lightning bolt struck nearby, producing a big flash at eye level and a simultaneous bang, causing him to duck and leap at the same time. Most wildfires here are started by lightning early in the monsoon season, before the rains come to put them out, like the Nuttall fire in 2004, which began on a shoulder of the Pinalenos and catapulted up the mountain, eventually devouring 29,000 acres.

That blaze became an emergency for the Forest Service because of the Mount Graham International Observatory. Hodges pointed from the overlook to a boxy telescope, still under construction. Pale green, it towered over a phalanx of unburned conifers. Two smaller telescopes lay behind it. An irony of the fire and others like it is that Forest Service crews ignited a rival conflagration, trading on favorable winds. They "backfired" the woods near the telescopes before the main fire could get there. The burnout spread fiercely. When it was over, the greatest damage to the forest was man-made.

There's more to the story, however. Why did the Nuttall fire blow up, given that lightning strikes are a dime a dozen in these parts? Normally, spruce-fir woods are insulated from fire by cool temperatures and soggy ground. Although the trees burn easily, they don't burn often, perhaps once every 200 or 300 years. Conditions have to be just right. What made conditions perfect in 2004?

One factor was an outbreak of insects that began in the late 1990s, concurrent with a drought. Sapped by attacks from an exotic aphid, a moth, and two species of bark beetles, the spruce-fir zone in the Pinalenos was scrofulous and drier than normal. Second, the vegetative zone below the summit had become a tinderbox. Pine and Douglas fir populate the mixed-conifer zone; it was overstocked with woody fuel. Also, Engelmann spruce and cork-bark fir had migrated downward in recent decades, nestling beneath the taller conifers like so much kindling.

"Things were out of whack," summarized a Forest Service biologist. Not that the agency was caught unawares. Its own policies had created the conditions.

Ten years earlier, scientists with the Laboratory of Tree-Ring Research at the University of Arizona published a paper on the fire history of the Pinalenos. Analyzing fire scars in the growth rings of old wood, the researchers determined that the last widespread blaze on the upper elevations of the mountain had taken place in 1685. The blaze probably cleared the spruce and fir from the peak, because no trees in the current stand are older than 300 years.

The record was more complicated in the mixed-conifer zone below. Burn marks appeared in the tree rings at roughly 10-year intervals for several hundred years. Except for the 1685 event, fires in this zone probably did not reach the top. But the marks ceased after 1880, when people took command of the mountains and declared war on wildfire. Thus for a century the fuels accumulated in the conifer belts of the Pinalenos. The university scientists warned of severe fires. "It is not a matter of if such fires will occur but when," they wrote, and the Nuttall fire proved them right.

All of which points to the central paradox of fire in the sky islands: Big wildfires happen when small wildfires are put out. Big fires have erupted in the 21st century because firefighting in the 20th century was too aggressive. Regular, modest doses of fire, scientists now say, keep the sky islands healthy. Fire maintains the ecological structure, the stacked life zones each in its place, and also the diversity of species, because many animals and plants benefit from the patches of new habitat created by low-intensity burning. Withhold fire and things get "out of whack."

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The same is true all over the Southwest. Since the 1970s, state and federal agencies have tried to encourage small fires in the forests and parks. To smooth the return of the old regime, brush and saplings have been cut, and prophylactic burns have been set. Nevertheless, the number, the size, and the intensity of wildland fires are increasing, such is the backlog of fuels. The Forest Service is like a weak government negotiating with a powerful political exile. Fire will come back on its own terms whenever it wants.

Here is a list of the major wildfires in sky island ranges since 1994: Rattlesnake fire (Chiricahuas, 1994, 27,500 acres burned); Clark Peak fire (Pinalenos, 1996, 6,300 acres); Bullock fire (Catalinas, 2002, 30,000 acres); Aspen fire (Catalinas, 2003, 85,000 acres); Nuttall fire (Pinalenos, 2004, 29,000 acres); Florida fire (Santa Ritas, 2005, 23,000 acres). These fires took place against the backdrop of even larger blazes elsewhere in Arizona. The Cave Creek Complex fire burned a quarter million acres last year, helping to make 2005 the worst fire season in state history. That is, in its modern history.

The prettiest approach to a sky island is along a flat highway through a yellow desert toward a blue mountain on the horizon. That's how the Chiricahuas look on the drive east from Tucson. By the side of the road the agaves bloom: bulbous, golden flowers on 10-foot stalks indicating the death rattle of the plants after decades of life.

The goal of this expedition with David Hodges was to study the vegetative zones of a sky island from the bottom up and to pull apart their interlocking, inflammable histories. The Sonoran Desert, where the saguaro live, is the lowest vegetative zone, and it resists burning. But since exotic grasses have invaded—cheatgrass, Lehmann love grass, and buffel grass particularly—the fire risk has gone up. The grasses become thatched and dry at the start of fire season.

Ranching is responsible for the environmental transformation of the desert zone and of the next zone higher, known as semidesert grassland. Alien seeds have been imported along with the alien cattle, gaining a foothold when slower-growing bunchgrasses were cropped back. Although it's hard to imagine now, Arizona was almost lush with waving grass in the 18th and early 19th centuries.

Those native grasslands burned all the time. Million-acre fires may not have been uncommon. Some of the fires were sparked by lightning; others were set by Indians, who found that game could be sighted better when the cover was removed. The Apache used fire and smoke to confuse their enemies. After the Apache chief Geronimo surrendered to the Army in 1886, settlers and their herds

of cattle and sheep flooded into southeastern Arizona.

As Hodges says, fire exclusion set the stage for fire suppression. The livestock changed the fire regime by eating up the grassy fuels. Fire could no longer roam the valleys and radiate into the mountains. Lightning still caused big fires in the upper elevations, until the Forest Service intervened. The Chiricahuas had a massive fire the year that Geronimo surrendered, but there were no others of consequence for a century afterward.

The grasslands are all but gone. Mesquite, manzanita, and other woody plants, which cattle don't care for, have moved in from above. The shrubs draw more water from the soil than grass does, and their woody biomass magnifies the fire risk. Meanwhile cholla, cactus, catclaw, and other desert plants have migrated upward. Biologists don't believe that the grassland vegetation can ever be restored to what it was. So they have set their sights higher, on the forested portions of the mountains, where fire acts as a double-edged sword.

Leaving the desert, the road mounted through scrub and thin, hardwood timber. In this zone, Hodges said, there are as many as 17 types of oaks. To him oaks are the "totem species" of the sky islands. Wildfires on the lower slopes usually burn everything, but the oaks sprout from their roots and bounce back.

As you come to 7,000 feet in the Chiricahuas, ponderosa pines appear, and slants of shade. The ponderosa pine is the premier tree of the Southwest. The aboriginal forests of Arizona were roomy underneath, and the tall trees stood well apart. Every 5 or 10 years a fire would meander along the ground, excising brush without blowing up into the crowns. A mature ponderosa pine sheds its lower limbs, and its checkerboard bark is fire-resistant, two factors that deny flames a "ladder." Over time the fire-adapted ponderosa pine will drive out all competitors.

Stopping in a glade, Hodges showed a characteristic black, triangular "catface" scar at the base of a tree. A surface fire, smoldering in the twigs and needles that collect on the uphill side of the pine, instigated the scar. The next fire perpetuated the scar and likewise the next, and all the while the tree continued to grow. "Scars are a sign of regular firings," said Hodges. "They predate the fire suppression era." After sporadic logging began in the sky islands, the Forest Service nipped most fires in the bud.

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When a surface fire did manage to crown, it would kill trees and make a hole in the forest, after which, more often than not, the fire would drop back down and resume its slow crawl beneath the pines. Stoked by thick ladder fuels, crown fires of recent years have spread farther and faster, leaving much bigger gaps. Case in point: the Rattlesnake fire, which started in the pines of the Chiricahuas during a hot spell in 1994. Helicopters attacked it with water and flame retardant, but the fire raced uphill into a dense mixed-conifer forest and burned uncontrollably for three weeks. When the rains finally came, the erosion of the denuded slopes loosed so much soil that a lake below the forest was completely filled in.

The hiking trail that Hodges chose skirted the fire's damage, which was still plain a decade later. Aspens had sprung up in the open patches, as well as opportunistic wildflowers like meadow arnica, with its floppy yellow blossoms, and scarlet-bearded penstemon, jauntily erect. Fifty yards farther along, the hulking Douglas fir and ponderosa seemed not to have been touched. There were bluebirds, hairy woodpeckers, and yellow-eyed juncos. A family of goshawks—dark-winged, acrobatic raptors—swooped low over the trees.

The higher you go in these mountains, the more you feel yourself being funneled into the sky. Unexpectedly the earth will fall away. Views burst outward, uncovering the khaki-colored desert far below, with blackened snags fringing the picture. Earth, air, and fire are close at hand, while the fourth element, water, is organizing into thunderheads. Great, grumbling clouds advance upon the Chiricahuas from the north, but the rain they release doesn't reach the ground. Instead, waves of fine droplets are parted by the mountain, as by a ship's prow, and the storm sails south.

The Laboratory of Tree-Ring Research is in the football stadium of the University of Arizona in downtown Tucson. Hunting for information on the deep history of fire, you worry that you're in the wrong place. But the faculty offices and the lab archives, full of old wood, are situated in the wedge of space between the west seats of the football field and the stadium's outer wall.

Tom Swetnam, the scientific director, and Don Falk, an ecologist, unlock a door in a corridor near the 40-yard line. Out flows a warm, ligneous aroma. The shelves inside are stacked to the ceiling with platter-sized sections of trees. Some of the wood is dusty and loose, and some is kept in sleeves in labeled drawers.

The scientists make their way downfield past wood from South Africa, past 5,000-year-old bristlecone pine, pale with spidery whorls, past giant sequoia, its slabs like the paws of defensive tackles.

At about the 10-yard line, Swetnam bends and pulls out some wood from the Animas Mountains. The Animas are a sky island system in New Mexico. "Southwestern white pine?" he hazards, handing the piece off to Falk.

Sniffing it, Falk says, "I think so."

Dendrochronology, they explain, involves much more than dating a tree by counting its rings. A record of climate change, insect attacks, and wildfires, among other contingencies, is wrapped up in the rings. The birth date of this white pine, 1695, is marked in

pen at the pith, the tree's central stem. Subsequent dates indicate the fire scars. At 1851, for example, there is a dark fleck of discoloration and a particularly narrow ring, a sign of poor growth during that year. Historical accounts speak of a very large fire in the region in 1851. For a contrast they show a section of younger wood from another sky island, the Huachucas, totally devoid of scars in the 20th century.

It is interesting to see scarring from the internal vantage of the tree. A small part of the tree's circumference is killed, so the wood there stops growing. The rest of the cambium layer and bark continue to expand around the injured portion. Even as the scar is renewed by ensuing burns, the new growth pinches from two sides. If the tree escapes fire for a time, the scar may close over and disappear from sight. The tree-ring history of the mountains makes clear that fires used to burn frequently but did not wound each tree every time.

"A rule of thumb," Swetnam says, "is that once or twice a decade, over 20 to 30 acres, a ground fire swept through the sky island pine forest. These surface fires occurred at longer intervals in the heights of the sky islands—in the mixed conifers. Also, crown firing was more common up and out of the ponderosa." Asked why a fire would crown more readily in the mixed conifers, Swetnam says emphatically, "Because it's a freight train coming up from the pines below." The freight train roars where the fuels are thickest.

In thinking about how to restore today's forests to more balanced conditions, the researchers at the tree-ring laboratory favor the standard combination of mechanical thinning and prescribed burning. Also, they say that forest managers and the public should expect a greater number of crown fires, although these will be alarming. Whatever the policy, there can be no ideal forest to shoot for, no perfect mix of species and spacing to restore. As Falk notes, global warming during the last century would have changed the forest even if fires had not been suppressed.

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"Any idea of equilibrium—forget it," Falk says. "Fire, climate, and insects—all of these are converging on the dynamics of the forest. It's a pinball. Nothing is standing still." The best strategy is to get wildfires working again as freely as possible. Triggered in times of heat and drought, abating in periods of wet, fires naturally keep pace with the environmental flux of the future.

Will the hands-off advice be taken? Falk makes a few turns through the warren of the lab and emerges in the 110-degree sunlight of the football field. Taking the steps two at a time, he climbs to the topmost row of seats, in the spruce-fir zone of the stadium, as it were. He points to a sky island 35 miles south. You can see broad, lazy lines of white smoke around the waist of the mountains and hotter, darker whorls above the mixed-conifer belt. The Santa Ritas were burning, but a thousand firefighters were pushing back.

Wildland fire use, in the terminology of the Forest Service, means not doing anything to put out a fire. The term applies only to naturally ignited blazes. It's like prescribed burning without the human agency. The agency may opt to "use" a natural fire to clean out an overgrown forest. Last summer the Coronado National Forest adopted wildland fire use for the entire sky island system. Previously the policy applied only to wilderness areas in the highest and remotest parts of the mountains. Under the policy, managers could, strictly speaking, allow a fire in the Catalinas or the Rincon Mountains, the ranges adjacent to Tucson, to burn right to the city limits.

The Forest Service calls its border with Tucson the wildland-urban interface, and in practice no fire is allowed to get near it because of the roads and homes there. According to the Coronado Web site: "Approximately 34,000 acres of the Forest are in urban interface areas. In the Tucson area alone there are approximately 60 miles of interface. The mixture of houses, flashy fuels, and brush fields in full view of a large metropolitan area adds significantly to the challenges and complexity of even the smallest wildland fire." Another Forest Service document notes: "Most wildland-urban interface fire problems are in ponderosa forests because these forests are so widespread, so pleasant to live in, and so extremely fire dependent."

Tucson's suburbs having sprawled to the Santa Rita range, a big problem arose last July 7, when lightning sparked a fire on Florida Peak. The Santa Ritas had not burned extensively since 1892. Because flames travel more slowly downhill than up, the Forest Service had a little time to figure out what to do. Wildland fire use was considered and rejected: The pre-monsoonal conditions were too dry and the urban interface too near. A crew of about 80 was sent into the mountains. With the blaze still relatively small and superficial, the firefighters began to dig a containment line around it, scraping off the burnable vegetation, while aircraft dumped water and chemical retardant. Then a strong north wind came up, and the fire crowned. The local crew was pulled off the mountain. A "hotshot" regional team came in with a more muscular and more conservative containment plan. The rugged, high elevations of the Santa Ritas would be permitted to burn, and key structures in the urban interface would be protected by controlled fires on their perimeters.

The two pressing obligations on the west side of the range were Madera Canyon, a resort community and popular bird-watching area, and the Mount Hopkins telescope. Fortunately, vegetation around the houses and lodges in Madera Canyon had been thinned in recent years. Firefighters prepared to burn out more brush and trees. On the east side of the Santa Ritas, which is sparsely populated, bulldozers dug lines and helicopters torched large swaths of the oak and juniper zone.

The temperature in Tucson had topped 100 degrees for 30 successive days, approaching a record. Although clouds swelled over the desert every afternoon, they fomented more wind than rain. It must have been scary at the telescope facility, which is perched over a deep canyon. The Forest Service dared to post only engine crews, who could jump into their vehicles and flee. If the fire took hold in the canyon, it could charge up the slope in two hours.

A week after starting, the Florida fire, including its man-made satellites, covered 20,000 acres. Officials estimated that 55,000 acres would burn. But on July 16, with 986 firefighters on the scene, the monsoon arrived, and an inch of rain fell. The fire lay down and the fight went out of it. About 23,000 acres would burn. Owing to the hopscotch pattern of the flames, the destruction in the mixed-conifer zone was less than feared. So the Florida fire turned out to be a pretty good fire.

The human containment effort cost $8 million.

You don't hear much about the Rincons, whose foothills are on the eastern edge of Tucson, because residents and tourists are drawn to the Catalinas, on the north. The Catalinas are the more attractive range, bold and blue, like a mural for the city, while the Rincons are lumpy and out of the way. The Catalinas have a paved road and bustling summer colonies and a winter ski resort; the Rincons have horseback-riding and hiking trails.

The Forest Service built a firehouse high in the Catalinas for faster response. When the service built a lookout tower in the Rincons, the goal was to look for smoke in the other range. Because of poor access, it was hard to combat fires in the Rincons. But the most important difference between the two ranges is that the Rincons are the only sky island supervised entirely by the National Park Service.

The Park Service took over the Rincons in 1937. Guided by progressive conservationists, its managers embraced the ecological benefits of fire before the Forest Service did. As a result, the era of aggressive fire suppression in the Rincons did not last long. Between 1937 and 2000 there were 414 fires on Mica Mountain, a high point in the range. Six were prescribed burns; 25 were accidental, human-caused fires; and the rest were due to lightning. Only the accidental blazes were extinguished. None of the fires were huge. The Catalinas had almost no fires to report during this period, and then were wracked by the Bullock and Aspen fires in 2002 and 2003.

David Hodges called the Park Service's handling of fire in the Rincons "the best fire program in the nation" and "a lesson in how to get back to a natural regime." Said Don Falk of the tree-ring laboratory, "The forest is more open—healthy—compared to the Catalinas."

"This area does emulate an uninterrupted fire regime," said Falk's colleague Calvin Farris, who is writing his Ph.D. dissertation on the Rincons. Some of the pine groves on the rocky east side of Mica Mountain have been scarred 10 times since 1925—scarred but never killed. "Lightning hits it directly, and fires climb to it from elsewhere," said Farris, who described "big surviving trees and grass below, on an open forest floor." Mica Mountain was worth visiting.

If you hike the Rincons in summer, you must start early in the day, or the heat will stop you. The elevation gain from the trailhead at Happy Valley to the summit is 4,000 feet, and steep all the way. For the first hour you're in high desert. With a hurried eye, you notice yucca and manzanita giving way to scrub oaks. There are charred stumps in the glittering soil (that's the mica). You see a Chihuahua pine, wizened and short, and then taller oaks. Shade commences halfway. Before noon the first thunderhead, ballooning over the still-distant peak.

Big ponderosa pines here and there. A cool sky island wind snatches your breath away. Other mountains have climbed into view when you turn around and look. It's getting more and more beautiful. A prairie falcon is rising and dipping along the line of an invisible wave, a dark particle of light traveling straight from sight.

Nearing 8,000 feet, you come to the ideal glade. Well, not the ideal, because there is no such thing in nature's cauldron, and besides the pines in the glade are a bit young, maybe 100 years old. But they are gracefully separated, with no lower limbs, and the carpet of needles and ferns at their feet is soft enough for a children's birthday party. Wander around. If you check a tree at random, it's there, the sky island badge, the catface scar.