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Pyrocene Park

Fire is a planetary feature, not a biotic bug. What can we learn from Yosemite's experiment to restore natural fire?

by Stephen J Pyne

Stand at Glacier Point and you'll instantly understand why it is one of North America's iconic overlooks. The great trough of Yosemite Valley in California fills foreground below and, with almost gravitational pull, carries the eye eastward to the crestline of the Sierra Nevada mountains. With its sheer granite walls, waterfalls that plunge hundreds of metres and uniquely sculpted sentinel monoliths (such as El Capitan and Half Dome), the scene beggars words like 'monumental'. It's a landscape shaped by Pleistocene ice that widened and deepened valleys, rounde exposed granite, cached boulders and soils, and scoured routes for runoff that eventually became rivers and waterfalls. Even today, its groves of sequoia, a charismatic megaflora, inhabit sites where the ice failed to enter.

Pivot south, however, and you'll see a scene as aesthetically bland as Yosemite Valley is gripping. The eye passes over it as fast as a stone skimming across a lake. The Illilouette Creek Basin is broad and rumpled, its granite surface camouflaged by forest, lacking the bold monoliths that make Yosemite Valley instantly recognisable, bequeathing a landscape unstoried and unremarkable. In the Illilouette, every iconic feature in Yosemite Valley has seemingly been inverted.

Yet a century after Yosemite National Park was first established, the Illilouette became a serious focus for management. The reason? It is a landscape informed by fire as fully as the Valley was by ice, and, equally, its rock-exposed perimeter tends contain fire within it, rendering it a kind of fire island. In 1972, those properties inspired a bold experiment to restore natural fire. This involved ending the suppression of fires kindled by lightning strikes and allowing them to burn freely (under the right conditions). Amid national enthusiasm for all things wild, and in place chartered to preserve the natural scenery 'unimpaired' for future generations, reinstating a natural process seemed an obvious thing to do. At that time, the fire community of fire officers, administrators and researchers regarded the US national estate as headed toward an impending disaster. Thanks to land use, not least fire's exclusion, wildlands were reorganising in ways that built up combustible vegetation to dangerous levels and allowed ecological dry rot to damage fire-impoverished landscapes. The Illilouette experiment was an attempt to let nature recover using nature's own means.

Over the next 50 years, the horizon of that project lengthened beyond the granitic rim of the Illilouette. What started as a crisis visible in public wildlands metastasised into a generally acknowledged planetary calamity. The Pleistocene has evolved int Pyrocene. Everywhere, fire is replacing ice. Uncontrollable wildfires ramble across open lands; untamed fires transform biomes from peat and forest into plantations and pastures; and fires encased by machines bloat the atmosphere with greenhouse gases, acidify the oceans, and enable a global wave of extinction. Even the cars, buses and asphalt that traditionally defined Yosemite's management obsessions are possible only because of humanity's combustion habits. In the Pyrocene, every defining trait of an ice age has seemingly been inverted into a fiery equivalent. Yosemite's fire history stands as a cameo for the Earth's.

Yosemite (1887) by Thomas Hill. *Courtesy the Blanton Museum of Art*

Yosemite is special. In 1864, amid a bitter civil war, Congress set aside Yosemite Valley and the Mariposa Grove of giant sequoias, ceding management to the stat California. At the time, the Miwok Indigenous people annually burned both the Valley and the Grove to facilitate access, hunting and prevent bad fires. Between the fires caused by lightning strikes and travellers burning along trails (to keep paths clear and assist hunting), the backcountry burned as well. Smoke was constant and, according to early observers, scorch marks were visible on nearly every tree: 'There not to be found now in the whole forest any tree of great magnitude which has not upon it the marks of fire.'

However, it was those lands savaged by 'fire and axe' – 'skinned', as a later US president put it – that so often accompanied the evolving European imperium and led to demands for intervention. State-sponsored conservation, mostly through extensive forest reserves, became a global project, part of the sanctioning of European rule. Staying the axe was politically problematic, but success was easily measured. Ending fire was more intractable.

From the beginning, Yosemite's fires provoked controversy. Authorities denounce fire as environmentally damaging, a kind of vandalism; an emblem of unenlightened primitivism; and messy, an index of social disorder. These were views commonly held by Europe's elites, and accepted as axioms by foresters. They applied as much to Europe's traditional fire users (and settler newcomers) as they did to Indigenous peoples in colonies from California to India and Australia, and in Europe itself, from Finland to Greece. The United States' first professional forester, Bernhard Fernow, dismissed the causes behind the country's simmering landscapes as one of 'bad habits and loose morals'. Western Australia's conservator of forests, Stephen Kessell, grumbled that 'only a few years ago the general public felt no compunction about setting the wild and untended forest alight whenever opportunity presented itself

> Combined with windfall, those young woods threatened the giants with wildfire

Nearly everywhere that Europe or European-inspired modernity went, it found

landscapes routinely ablaze, and everywhere authorities made fire's suppression a foundational doctrine of conservation. Protecting forests from fire was a hallmark civilisation. Yosemite's Board of Commissioners applauded Galen Clark, 'guardian' of Yosemite, for shielding the park from wanton fire. Park commissioner Frederick Law Olmsted, famous for designing Central Park in New York City, denounced

'Indians and others' (primarily shepherds) for their promiscuous burning. Even Muir, the *genius loci* of Yosemite and one of era's great observers of nature, wrote 1876 that fire 'is the arch destroyer of our forests, and sequoia forests suffer most of all'.

But almost immediately the abolition of fire caused problems. Without routine flushing by flames, young trees filled up both Valley and Grove. Within a handful years, it became difficult to view the granite walls and towering waterfalls that brought tourists to the Valley, while white fir and incense cedar crowded around a obscured the giant sequoias. Worse, combined with windfall, those young woods threatened the giants with wildfire. To those who already distrusted fire, that enhanced threat argued for yet more protection against fire, which set up a cycle well-intentioned but self-defeating policies. In 1889, wildfire did enter the Grove. failure to halt the flames, combined with other concerns, led Congress to return Yosemite to federal control the next year. Whatever its views, the commission had never had enough resources to actively manage the park, but the federal government did.

Not all the commissioners had objected to fire. William H Mills, for example, loudly proclaimed that he had 'always respected the ability of the Indians to manage that valley' and that he regarded fire 'as a very good method of management'. The removal of fire had only catalysed unwelcome change. Such views were prominent among people who actually lived on the land, as well as several other commissioners and various observers. However, the official policy (promulgated by the Department of the Interior) made fire-starting illegal.

The federal government sent in the US Army to establish firmer control. Every summer from 1890 to 1914, a cavalry detachment bivouacked outside the Marip Grove, and later Yosemite Valley, enforcing rules against trespass, timber theft and fires. The army soon appreciated both the extent of burning and its value, and many officers actually argued for a programme of regular burning. Captain G H G Gale

noted as ‘a well-known fact that the Indians burned the forest annually’ and then concluded that the ‘absolute prevention of fires in these mountains will eventually lead to disastrous results.’

Nearly everyone in the mountains agreed, except officials. What became known as the ‘light burning’ controversy bubbled up in California during the first two decades of the 20th century. Light burners referred to those who argued that the US should emulate its Indigenous peoples and routinely burn forests, instead of conforming to European forestry. Foresters saw this as a challenge not only to their competence as firefighters but to their credibility and legitimacy as agents of conservation. The chief forester William Greeley dismissed light burning as, in his words, Paiute forestry – referring to the burning practices of Indigenous Paiute peoples. In 1923, a commission convened by California’s Board of Forestry ruled against light burning, and the practice became anathema. Fire policy remained unchanged.

ThThe same controversy bubbled up wherever modernity met traditional societies. An essentially identical discussion occurred in British India in the 1870s under the rubric of ‘fire conservancy’ with similar splits between those in authority and those charged with executing policy on the ground. Eventually, British foresters had to compromise in practice, though never in principle, and French foresters did the same (by looking the other way). Those in power would never formally acknowledge burning as legitimate land use because it defied the science of the day and bore a stigma of primitivism. Besides, fire was too useful as an emblem of wrecked lands. still is: think of how fire is used today to symbolise climate crisis.) The public, they argued, would be confused if asked to distinguish between long-standing burning practices and the ruinous burns that feasted on the offal of logging and land-cleari

Half a century later, Yosemite’s forester Emil Ernst noted that: ‘Up until about 1906 this policy of fire suppression was openly and actively condemned by the highest responsible officials who, however, disregarded their own opinions and carried o u the fire suppression and fire prevention policies with which they heartily and hon disagreed.’ That intellectual dissonance became institutionalised. In reality, the authorities had it backward. The real menace was mindless fire-fighting, not fire-lighting.

The civilian National Park Service arrived in 1916. It continued the cavalry's pract and, though it kept its grey uniform and campaign hat, it lacked much capacity to apply fire control at scale. In 1928, the national office hired John Coffman, a ranger who had previously worked for the Mendocino National Forest – a hotbed of incendiarism – to create a more modern organisation. The resulting reforms made Yosemite a model park for fire protection.

In 1930, the park erected a lookout and a guard station, and began keeping formal records of fires. In 1933, it was granted the money and muscle it needed to enforc the fire exclusion edict with the arrival of the New Deal, emergency conservation programmes, and the Civilian Conservation Corps. Bolstered by that same largesse, the Forest Service announced in 1935 a universal mandate to control every fire by 10am the next morning. As an administrative edict, it was brilliant – unambiguous, quantitative, dramatic. As a guide to ecosystem health and fire protection, it was hopelessly flawed. It was a policy for cities, not the countryside.

A boisterous forest of the future now looked li dysfunctional woods ready to explode in flam

Yosemite's fire history conforms broadly to that of public lands everywhere in the country. American-style fire suppression had congealed in response to a complex great fires in 1910 – the fabled 'Big Blowup'. For the next 50 years, led by the US Forest Service, the country laboured to remove fire from its national estate. But taking out bad fires it also extinguished good ones. By the 1960s, the consequen were becoming apparent as landscapes deteriorated and burnable vegetation ('fuels') piled up. Critics worried that the Big Blowup of 1910 would be followed by a Big Blowback at the end of the century.

Between 1962 and 1978, a reformation in fire thinking overturned previous doctrine. A new generation saw the same evidence differently, and a Gestalt-like switch took place in which what earlier generations had seen as a boisterous forest of the futu now looked like dysfunctional woods ready to explode in flame. In 1963, a commission chaired by Starker Leopold urged the Park Service to actively manage natural estate and cited the overgrown dog-hair thickets of the Sierra parks as a

poster child for the need to restore fire.

At the same time, research was progressing at Redwood Mountain, the world's largest sequoia grove. Most of the site lay along the west boundary of Sequoia-Kin Canyon National Park south of Grant Grove, but the University of California, Berkeley held part as an experimental forest, and under the charismatic leadership Harold Biswell conducted research on the dual threats posed by fire exclusion: thanks to encroaching woods, wildfire could reach into the crowns of even giants, and the absence of surface fire (which could purge competitors) limited sequoia regeneration. The Grove needed fire.

Jan van Wagtendonk sitting against a ponderosa pine with Harold Biswell (rear) ne
prescribed fire in 1970, in Yosemite National Park. *Photo by George Briggs/Nation
Parks Service*

Research plots were soon matched with demonstration plots for showing how tc
recover that lost fire. Most of the park fire staff for Sequoia-Kings and for Yosem
learned their skills on the slopes of Redwood Mountain and studied under Biswe
his colleague Starker Leopold. In 1968, the National Park Service replaced the 1
edict with a policy of fire restoration. Ten years later, the US Forest Service follov
suit. Deliberate, prescribed burning was one solution; another was to allow natu
fire more room to roam. In 1972, Yosemite designated the Illilouette watershed f
the experiment. The Illilouette provided proof-of-concept that became particular
important after the 1984 California Wilderness Act put 95 per cent of the park in
legal wilderness.

Firefighters conducting a controlled burn in Yosemite National Park in July 1977. *Courtesy National Parks Service*

A basin emptied of flame began, patch by patch, to fill up with it. Fire returned as lightning strikes set fuels ablaze (any human ignition was suppressed), some burning new places, some reburning previous burn scars as they rejuvenated. Fifty years lat only a fraction remained unburned at all. Even so, an estimated 24 per cent of the Illilouette's natural fires were suppressed. The major reasons were callouts of fire for wildfires elsewhere in the region and smoke filling in the Valley from fires that would sometimes linger for months. Paradoxically, wilderness status complicated restoration: it was acceptable to put out fires but not to light them, which meant a steady decay in the total area burned. Moreover, as bad fires worsened in Californ it could be awkward to justify keeping Yosemite alight with good fires or demanding that its inhouse fire crew tend its home fires rather than rally to the megafires that threatened surrounding lands.

In retrospect, experiments such as Yosemite's occurred at a benign time. When the Starr King fire burned almost 3,700 acres in the Illilouette in 1974, it seemed huge; 20 years later, you needed 30,000 acres to shock; and 40 years later, 300,000. e term 'megafire' was coined after the 2002 season; by 2019, 'gigafire' had entered fire community's lexicon. Legacy fuels were mating with the climate crisis and, as more fires threatened communities and saturated California's skies with smoke palls, it became harder to muster both the resources and the will to 'manage' rather than simply suppress outbreaks, however much those massive firefighting endeavours failed and added to the problem.

Yet the revolution to restore fire seems easy only in retrospect. Even 'letting fires burn' was an active choice with consequences that ranged far beyond park boundaries. It was a revolution from the top that struggled to express itself on the ground. Policy could pivot quickly; practice could not. Most parks and national forests did not make the transition. Rather than two sides of the same fire-management coin, fire-fighting and fire-lighting often became rivals. At Yosemite, two groups had separate programmes in separate administrative bunkers. Fire suppression had tradition, equipment, crews and plenty of money. Fire management, which embraced a pluralism of fire practices, had an office in the attic (literally) of **the**

administrative building, few resources and scant funding. A failure to control a wildfire would prompt more effort to control it. A failure to control a prescribed fi could end a career. However natural its ignition source, however squarely embedded in legal wilderness, liability resides in the person or agency who decides to monit loose-herd or generally manage fire, not extinguish it instantly.

The checklists of go/no-go decision points that govern whether to allow a natural to proceed swell with each year, with every new social value identified, with every glitch and stumble in fire practice, and with every personnel transfer into and out the park. Fire management must cope with the Clean Water and Clean Air acts, with the Endangered Species Act, with the Wild and Scenic Rivers Act, with potentially threatened cultural resources, with visitor safety, with regional fire danger and available resources, with personalities among cooperators, with punishing drought (like the one that ran from 2012-15, colluding with beetles and killing 150 million California trees), and on and on. Any fire can be shut down for one of many reasons: gateway communities and concessioners don't want flame and smoke to discourage tourists or force the park to close; invasive plants can spread in the burn footprin callouts under the California master fire plan can divert crews from prescribed fires.

> The park was forced to impose fire restrictions which left the trekkers huddled around an LED-lit lantern

And then there is the threat of wretched air in the nearby San Joaquin Valley and prolonged smoke in Yosemite Valley, uncertain and unequal funding among asp of an integrated fire management programme, or concerns over the Hetch Hetch Reservoir (which provides municipal water for San Francisco). Any and all can encourage fire officers to end a fire. The required compromises are endless, and all point to fire suppression as a default setting. There is no comparable checklis which to quicken the reintroduction of fire. Even so, over the past half-century, enough fire has gotten in to keep the Illilouette from detonating. Monitoring demonstrates conclusively that the basin is far healthier and more resilient than outside the park.

In September 2021, the park arranged for its governing cadre, along with three academics, to trek into the Illilouette for a three-day retrospective on what 50 yea fire management had wrought. Even as the trekkers readied their gear, two fires along Yosemite's Tioga Road continued to be managed, loose-herded into burn footprints from the previous year – the Illilouette experiment had expanded to encompass most of the park outside the Valley and Grove. To counter their smok spreading into Yosemite Valley, two fires in the Illilouette had been extinguished earlier in the summer. The trek demonstrated the difficulties of managing fire today: not only in trying to make up losses from the past but preparing for the compounding threats posed by an accelerating fire epoch.

The cadre was pared down from 15 to 12 when the most senior staff had to exit f or more pressing duties. The pack train that would carry the group's heavy equipment misread maps or ignored instructions, and deposited the gear at a site that forced trekkers to backtrack. e opportunity to converse over policy and protocols while mellowing out over an evening campfire disappeared when, two weeks earlier, the park was forced to impose fire restrictions, which left the trekkers huddled around LED-lit lantern instead of real flames. Some of the best fire officers, fire scientists wilderness planners in California were unable to light a fire in a backcountry camp ring around which they could discuss how to restore fire at a landscape scale.

More tellingly, unfolding events showed that managing its fires was no longer something that the park could contain within itself. Three days before the trek, a lightning storm kindled three fires in the park, and another three at Sequoia-Kings Canyon; Yosemite's were extinguished, but the initial attack at Sequoia-Kings caught only two. Those fires soon merged into what became known as the KNP fire complex, and its smoke filled the southern horizon of the Illilouette, causing park personnel, including its fire management officer, to be dispatched to Sequoia-Kings. The fires had not stopped by the time the trek ended, but the cadre still debated what they meant – and, even as Yosemite continued to reboot its programme, demands from neighbouring parks continued to pull away its staff.

Over the past 30 years, fires have hammered at Yosemite's border and sometimes poured through. e A-Rock and Steamboat fires in 1990 forced the park to close the first time in its history.

the first time in its history. The Rim fire that started in 2013 burned 257,314 acres, some 77,000 within the park. The Ferguson fire of 2018 surged over the western boundary. In 2020, the Castle fire brushed against the park's south perimeter. Smok from border burns compelled the park to close twice. Further afield, the fires burning coal in China and India, those smouldering in Sumatran peat and felled Amazonian forest, and all those vehicles congesting roads in Yosemite and swarming across highways around the globe were bolstering a change in climate that added heft t conflagrations in a place naturally built to burn. e dialectic between burning liv landscapes and burning lithic ones, which is to say, fossil fuels, was reconfiguring on Earth. Yosemite could not escape its reach, any more than Australia could in 2019-20. Even Greenland burned.

The park has stumbled, too. In 2009 a prescribed fire in Big Meadow intended to protect the gateway community of Foresta escaped and blew up into a maelstrom of public and political criticism. Yosemite's entire fire programme was already immersed in a major upheaval in personnel that grumblers likened to a purge. By time the fire organisation regrouped, California was marinated in a historic drought that, along with insect outbreaks and fires, killed an estimated 150 million trees in the Sierra Nevada. Funds in fire budgets not directly related to community prote were stripped away. Fire staff positions went unfilled. Most of the park's needed burns came from wild rather than managed fires. It was felt that major projects should wait for better environmental and political circumstances in the future.

But the future was not more opportune. It was getting worse. Atmospheric carbon dioxide that had been 325 parts per million in 1972 was 415ppm in 2021; fuels had, in most places, only aggregated across another five decades; a recolonisation of rural landscapes by exurbanites had quickened, putting even more communities in harm's way. The firepower to suppress burning had become insurmountable, except during the worst conditions, which is exactly the time when fire control is most needed. What had seemed like unprecedented challenges would years later look like missed opportunities – a cycle that repeated decade after decade.

> The mature sequoias were adapted to fire, but not to the savagery of such burns

At all levels of Yosemite's administration, fire is now regarded as a critical issue, if yet an existential one. A new round of reforms and restarts is underway. The park considers its fire programme a 'beacon' to others, and the park's chief of staff believes the park is now headed into 'a golden age of fire management'. The fire programme has a full roster, and prescribed burns are lighting up Yosemite Valley while thinning and burning projects are underway at the Merced and Tuolumne groves.

Throughout the 50-year reformation in fire management, Sequoia-Kings Canyon Yosemite had shared knowledge, personnel and an origin story birthed at Redwo Mountain Grove. What happened to one was an omen for the other. In September 2021, the KNP fire complex worsened, and crews hurriedly cleared around developed areas, draped aluminium foil around the trunks of giant sequoias, and burned out along the Generals Highway that connected the parks' various groves, hoping to back the fire down Redwood Mountain itself.

On 4 October, those fires blew up. A pyrocumulus plume towered over the largest concentration of sequoias in the world, and an unknown number of mature redwoods were incinerated. Combined with the 2020 season, an estimated 15-20 p cent of Earth's mature sequoias died. The big trees were famously adapted to fire, not to the savagery of such burns, or likely the severity of the maturing fire age. Hopeful observers noted that the KNP fire complex could have been worse, and that the park now had an 88,307-acre burn scar by which to anchor future 'treatment such as thinning woods, setting prescribed burns and managing wildfires.

Nature demands a fire tithe, and Yosemite had managed to pay only part of it through fire restoration – enough to keep going, not enough to pay down the principle. To some observers, the debt was growing faster than it was being bought down. This was not where Yosemite needed to be, and its neighbour was in a similar position. Sequoia-Kings had 11,000 acres of sequoias and, over the 50 years sinc restoration had become policy, it needed to treat only 220 acres a year, but had fa Yosemite had secured the Mariposa Grove, its biotic Parthenon, though not the Grove's periphery, and had left mostly untreated the overgrown Tuolumne and Merced groves. Even the Illilouette – a showcase project in a showcase park – has never made up its fire deficit.

Other, more immediate crises, commitments and exercises in risk aversion had resulted in half-steps, distractions and diversions, each justifiable at the time, but whose cumulative effect weakened the programme.

Yosemite shows what it takes to keep fire an ally rather than an enemy – fire is a relationship, not just a tool. Yosemite also demonstrates how hard this task is, and how what seemed bold in the past might appear feeble when measured against contemporary conditions. Yosemite is a flagship national park, the best-funded unit for fire management in the entire system, and occupies a prominent place in national fire reforms. Yet it survived by being lucky as much as by being good. Many plac are neither.

Even astute observers wrestle to cope with the three-body problem presented by natural fire, anthropogenic fire in living landscapes, and the combustion from burning lithic landscapes. ey struggle to truly appreciate the extent to which fi systemic rather than seasonal, a planetary feature not a biotic bug, a phenomenon whose plumes span from the geologic past into the geologic future. We don't yet fully apprehend the pervasiveness of the fire age that is reforging Earth.