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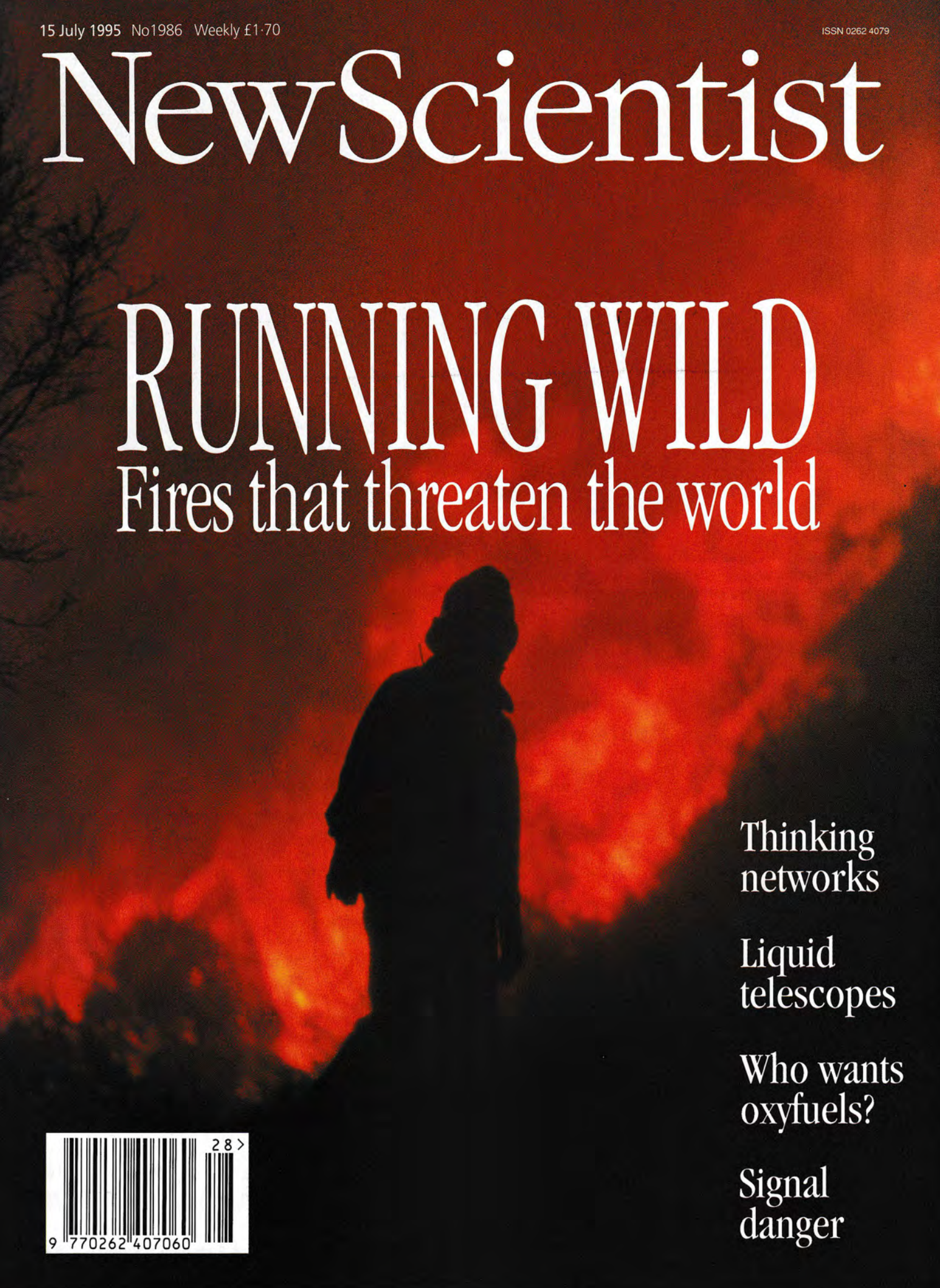
RUNNING WILD

Fires that threaten the world



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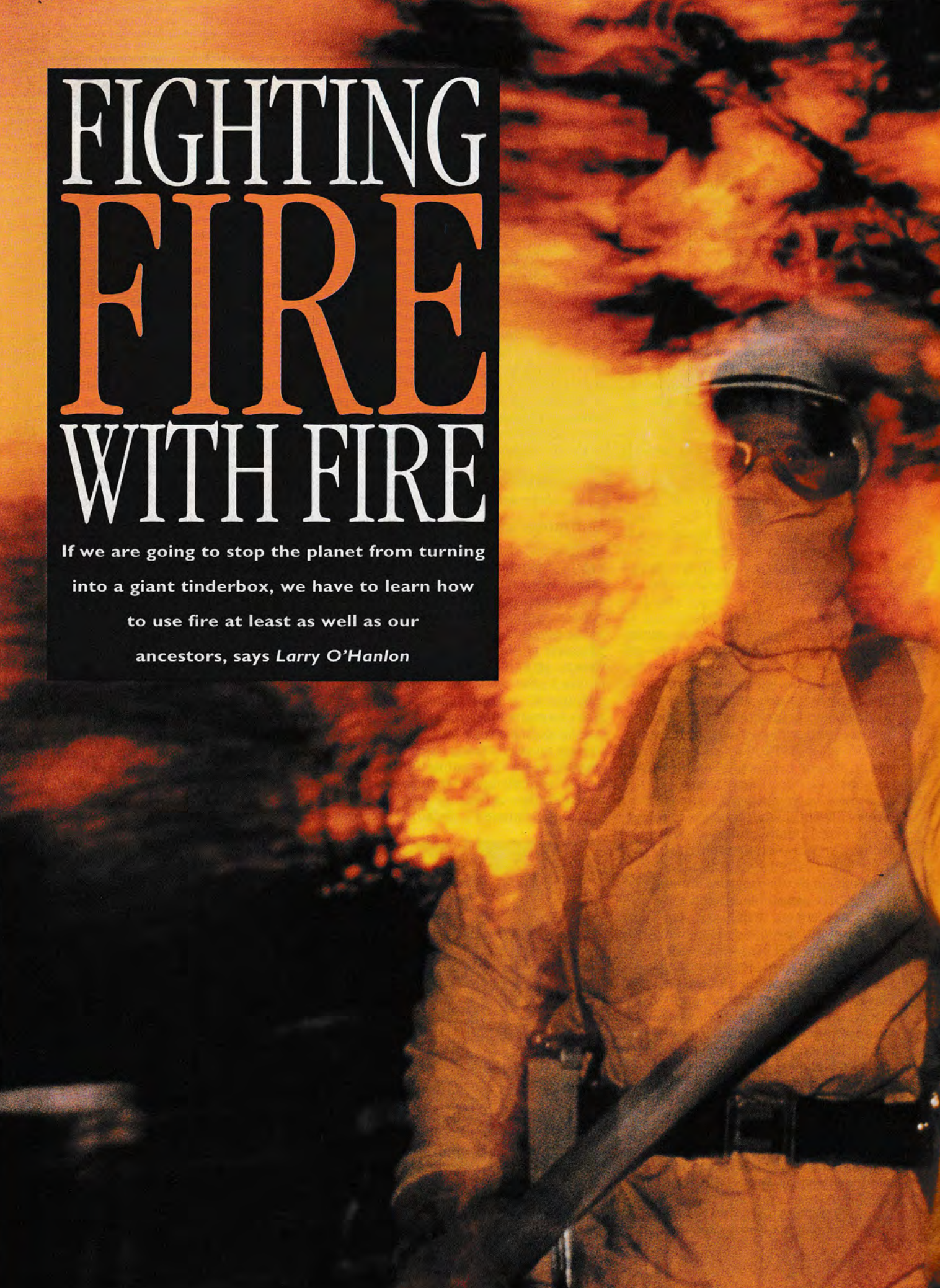

FIGHTING FIRE WITH FIRE

If we are going to stop the planet from turning into a giant tinderbox, we have to learn how to use fire at least as well as our ancestors, says *Larry O'Hanlon*

AS FLAMES roared up the ridge, through trees and brush near the town of Verdi in the Sierra Nevada, firefighters from the US Forest Service were not unduly worried. The fire would reach the far side of the ridge, they thought, then slow down or stop. That is the way a typical fire would behave. But little about this blaze and others last summer in the western US was typical. In a matter of minutes, the flames had crested the ridge and were charging unabated into the next canyon and beyond, leaving the firefighters scrambling.

"It was a life-changing experience," recalls John Swanson, the fire and timber chief for the US Forest Service at nearby Lake Tahoe and a veteran of many fires. Like others, Swanson came back from Verdi and similar wild blazes in the western US last year suspecting that the fires which sweep through these

Colorific

Fuelling the flames: heated political events and burning often go hand in hand (right) From the ashes: fresh growth after a bush fire in new South Wales (below)

landscapes had begun to change.

Researchers who study the geography and ecology of brush and forest fires have exactly the same fears—and not just about Californian fires. They believe that across the globe, from California to Australia and from the Mediterranean to South Africa, such wildfires are becoming hotter, more devastating and more frequent. Indeed, the pessimists among them talk about the planet being on the brink of a "global pandemic" of wildfires as a vast tinderbox of flammable shrubs and dead vegetation accumulates in forests, brush and grassland.

Discarded cigarettes

Nobody is suggesting that wildfires are anything new. It's just that in centuries and millennia past, the "surface fuels" that feed them would have been regularly ploughed under or burnt off by farmers and other land managers, or by hunter-gatherers who used controlled doses of fire to flush out prey or to protect hunting grounds from lightning strikes. But such practices have mostly fallen by the wayside. The result, the argument goes, is tracts of land at the mercy of carelessly discarded cigarettes, arsonists and lightning. The infernos that swept past Sydney at the beginning of last year, Los Angeles last summer and Jerusalem two weeks ago could be a taste of things to come.

If this pessimistic assessment is right—and no one can yet be certain that it is—what should governments do? Encourage controlled burning, or invest in better technologies for suppressing and fighting fires? Curb the expansion of suburbs into fire-prone countryside or attempt to build fireproof houses? Then there is global climate change to consider. Will it make wildfires more common? For that matter, what will more frequent fires do to the climate? Ecologists, fire researchers and land managers have only just begun to tackle such questions.

Though the scope for debate is still huge, one thing seems certain. Flames, heat and even smoke are among the forces that have shaped and sustained natural environments for millennia (see Box "Living with fire"). The idea that you can somehow exclude fire from natural environments in places like Australia and South Africa is a nonsense. European colonists and their descendants have discovered the hard way that the only real choice is between landscapes shaped by frequent, controlled fires and landscapes shaped by infrequent and unpredictable firestorms.

The fear is that we are about to get the latter by default, and anecdotal evidence seems to support this view. Last year's wind-whipped blazes near Los Angeles reached temperatures of around 1400 °C—hot enough to ignite the asphalt of the Pacific Coast Highway, according to one firefighter at the scene. Decades of growth and fire suppression had left abundant fuel, which in the favourable dry winds fed firestorms that resisted all human attempts at containment, and only fizzled out when they reached the Pacific Ocean. The extended suburbs added a new kind of fuel to the fire: people's homes.

Such disasters could hardly be more dramatic. But finding out whether they are part of a global trend is proving difficult, because reliable data are hard to come by. "The statistics for fire stink," says Stephen Pyne of Arizona State University West, whose book *World Fire: The Culture of Fire on Earth* analyses the histories of wildfires in Sweden, South Africa, North America, Siberia and many other parts of the globe. Wildfires have gone largely unmonitored by governments and scientists, and even where figures exist the picture is often blurred by the lack of clear definitions for classifying fires. For example, a lot of what was once agricultural burning is now considered to be wildfire, Pyne says. Even the word "forest" can lead to confusion. Europe is struggling with definitions of "forest fire" because legal definitions of what counts as forest often do not make biological sense. Another problem in assessing world trends in wildfires is which historical period you take as your starting point. Last century? 5000 years ago? "It matters," says Pyne.

Among the people trying to straighten out the statistical jumble is Johann Goldammer of the Fire Ecology Research Group at the Max Planck Institute for Chemistry in Freiburg, Germany. Goldammer is developing an information clearing house that will centralise and standardise statistics on fires. As the leader of a UN team of forest fire specialists, Goldammer is also managing an ambitious project to set up a Global Fire Management Facility that would monitor fires worldwide, organise and share fire specialists and firefighting equipment, coordinate fire-related research, and develop policies for controlling fires and managing vegetation.

Pyne believes the need for such measures has never been greater. Over the past 20 years, many policy makers have come to accept the idea that controlled burning is desirable, yet the amount of controlled burning in places such as California has actually plummeted. The

'FLAMMABLE DEBRIS KEEPS PILING UP IN FORESTS, GRASSLANDS AND FARMS LIKE SO MANY BUNDLES OF

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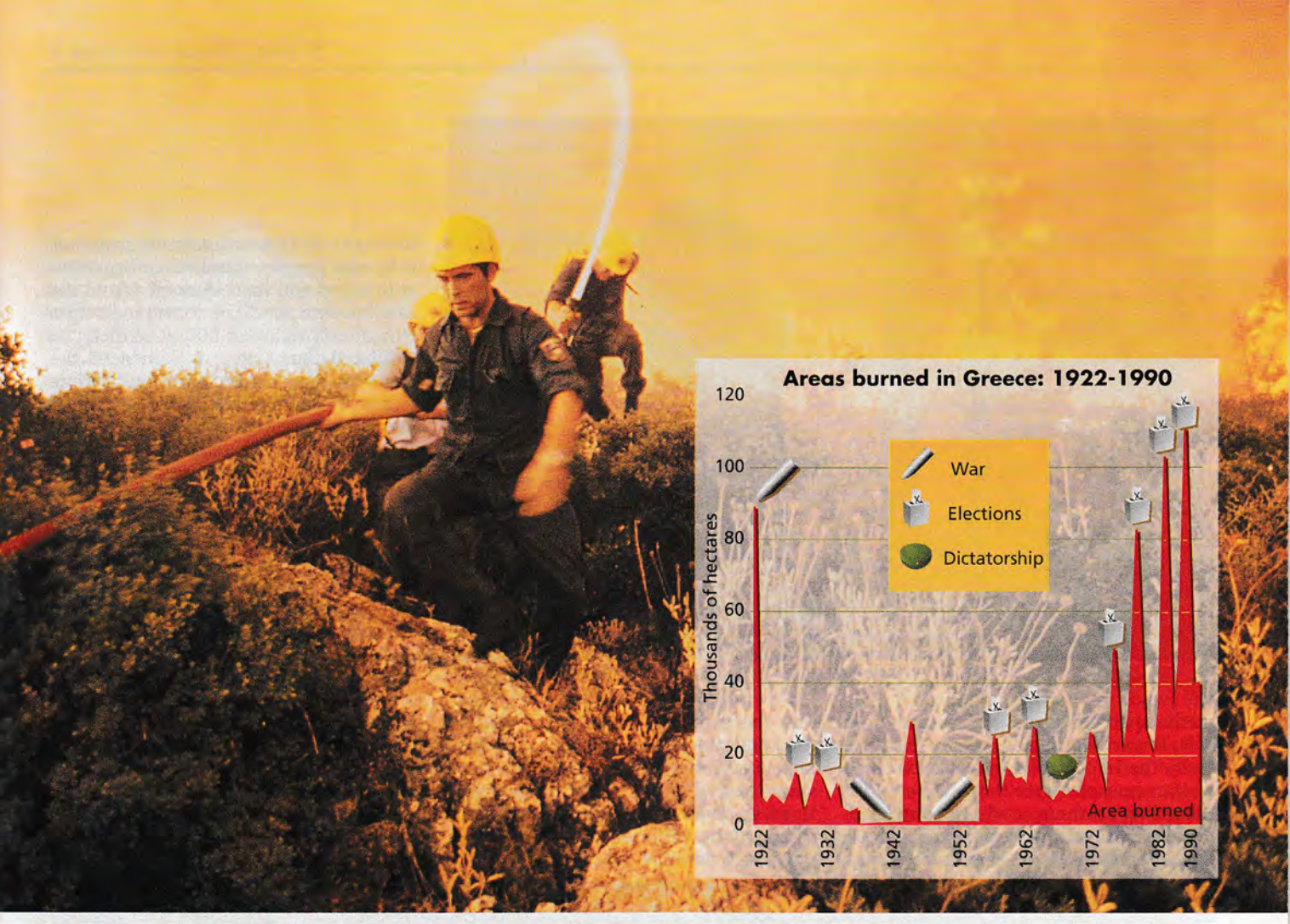


Frank Spooner Pictures

MITE—AND THIS IN A WORLD WHERE THE POLITICAL ENVIRONMENT IS MORE HAZARDOUS THAN EVER'

same is true, says Pyne, for the forests of Sweden and Finland and also around the Mediterranean, where 90 per cent of Europe's fires occur. Globally, he argues, "there is a whole lot less burning than in centuries past". He reckons that the area being burnt in this way today is a mere 20 per cent of what it was when Columbus discovered America.

The result is that flammable debris piles up in forests, grasslands and farms, like so many bundles of dynamite—and this in a world where the political environment is more hazardous than ever. To demonstrate what a dangerous combination this is, researchers point to the recent history of Greece. "During the 1980s it is generally believed that rightists tried to burn the country," says Goldammer. In fact, the areas burnt in the election years of the 1980s nearly trebled, from less than 40 000 hectares per year to nearly 120 000. The worst single year was 1993, when 2417 fires reduced to ash an area more than half that of New York City.

Russia could be next. According to Pyne's analysis, nearly 1 billion hectares of Russian forest are now at the mercy of the country's social unrest and political confusion. The emerging market economy will not necessarily help matters, either. Timber is a highly profitable commodity, and logging companies understandably look on fire as a threat to their livelihood. Yet suppressing all fires and cutting for quick profits could lead to thickly overgrown forests and infernos. And who then would pay for the fuel Siberian firefighters need to power their planes?

Tourist fears

But even if it is agreed that the planet needs more regular, controlled burning of its forest floors and grasslands, taking action will not be easy. Yes, national park managers in Australia, South Africa, California and other parts of the western US are doing whatever they can to bring "prescribed burning" back to conservation areas. But their resources are limited and the job requires detailed (and costly) monitoring of winds, humidity, the moisture content of forest floor debris and a host of other variables.

Other obstacles may prove even harder to overcome. In the resort area of Lake Tahoe in the Sierra Nevada, tourists and residents don't want smoke obscuring the alpine views. Never mind that clear, pristine air may be just another cultural construct. Before it was settled in the last century, around 800 hectares of Tahoe's forests burnt each year, Swanson estimates. Less than 16 hectares burnt there last summer—and that was considered a bad fire year.

Then there is the problem of spreading suburbs and the fears of rural homeowners. Burning undergrowth is dangerous. Burns that are supposed to be limited may break free, levelling homes and threatening entire towns, as happened in the tiny mountain town of Woodfords, California, in 1987.

Even if Californians accepted this risk, and were prepared to put up with the smoke, there are legal problems. California has some of the strictest air pollution standards in the world and a limited amount of "airshed" in which to dilute carbon dioxide, ozone and other pollutants. Prescribed burning and the burning of agricultural waste have to take their turn after high-priority polluters like cars and power stations.

Such restrictions are becoming increasingly contentious. Certainly, there are atmospheric chemists and air-quality specialists who argue against controlled burning. Too much vegetation, they say, already goes up in flames each year for

Sygma

one reason or another, pumping out CO_2, methane and toxic pollutants in the process. But ecologists and researchers who study the impact of vegetation burning on the atmosphere see things differently. According to them, curbing controlled burning to avoid pollution and greenhouse emissions is at best unnecessary and at worst a false economy. The real problem lies elsewhere—with burning vegetation for land clearance.

The distinction, though easily lost, is crucial. Controlled burning of landscapes to reduce surface fuels has been on the wane for decades. By contrast, the total amount of vegetation being burnt each year across the globe—which according to Pyne's historical analysis had been in decline in earlier centuries—seems to be climbing, due mainly to the clearance of forest, bush and savanna for agriculture and development in the tropics. A few years ago, Richard Houghton, a researcher at the Woods Hole Oceanographic Institution, Massachusetts, suggested that the carbon released every year to the atmosphere due to land clearing may have increased by about 50 per cent since the middle of the last century. But this was, by Houghton's own admission, just a crude estimate, and the race is now on to collect hard data.

At NASA's Atmospheric Sciences Division at the Langley Research Center in Hampton, Virginia, Joel Levine and his colleagues are studying a range of indicators of what they call "global biomass burning", including fires, deforestation rates and chemical analyses of air sampled on the ground and from planes. The main string to the researchers' bow, however, is satellite imaging. "We're using satellite datasets developed to study other things, like cloud formation and weather patterns, to find out the extent and frequency of burning," says Levine.

Since this has never before been done on a global scale, the researchers are having to write new computer programs that can extract detailed information about fires and land clearance from the satellite data. It will be some time before Houghton's figure of 50 per cent can be validated. But Levine is convinced the trend is for more burning. "We're destroying biomass each year, each day," he says—and not only that, he says, but this relentless destruction has contributed as much as 40 per cent of the CO_2 in the atmosphere today.

Benign destruction

But when it comes to controlled burning, fears about atmospheric pollution and CO_2 emissions are largely misplaced. "Prescribed and controlled fires are negligible in terms of the amount of biomass converted into CO_2, methane and other gases," says Levine. "In our calculations, we don't even have a category for how much material is released by prescribed burning."

It's not just a question of scale; controlled burning is environmentally benign in a deeper sense. Fire-prone landscapes will eventually burn with or without human intervention, so sooner or later the carbon locked up in the vegetation will be released into the atmosphere as CO_2. The key point is that after a controlled fire, vegetation regrows, absorbing CO_2 in the process. Indeed, by encouraging germination and new plant growth, certain types of fire—even wild blazes—may actually help the growth of vegetation. As long as the land is allowed to regenerate, the CO_2 absorbed should roughly balance that released during the burning.

'FIRE-PRONE LANDSCAPES WILL EVENTUALLY BURN WITH OR WITHOUT HUMAN INTERVENTION, SO SO

Goldammer concludes: "Recurrent savanna and dry forest fires do not contribute to a net release of carbon

Living with fire

In lightning-prone areas such as Australia, North America and South Africa, fire has always been a regular event, so plants and animals have evolved to cope with it.

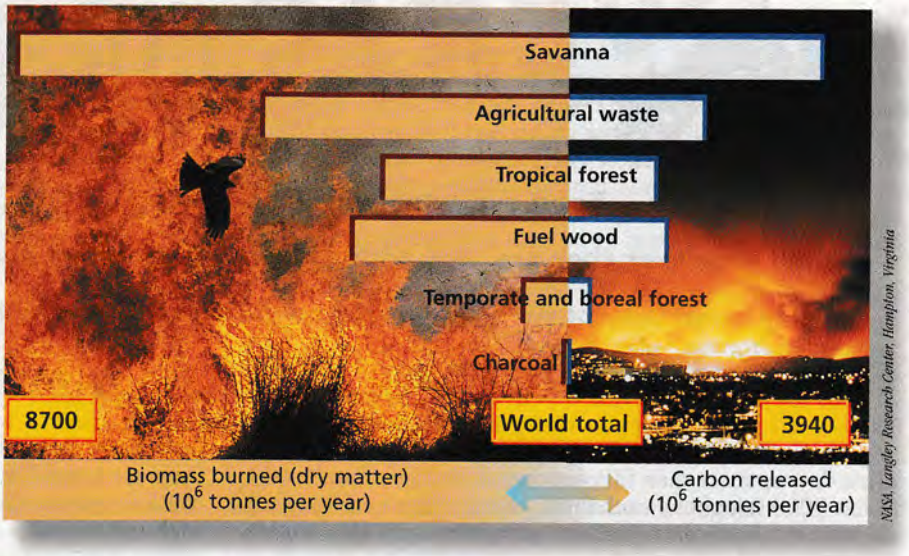
When humans tamed fire more than 500 000 years ago, they acquired an effective way of cleaning out the old debris to stimulate new, vigorous plant growth, and hence improve hunting and foraging. People quickly took over from lightning strikes as the leading starters of fires. In a classic example of ecological feedback, the flora and fauna of these fire-dependent ecologies in Australia, South Africa and California adapted to human-managed fire regimes, in which fires were probably more frequent and less intense than they had been before.

The results can be seen today in innumerable fire-adapted species. The heat of a quick ground fire is known to trigger some pine cones to open and release their seeds. Other seeds have wax-like coatings that have to be melted off before germination can occur. The giant sequoias of California's Sierra Nevada evolved a fire-resistant bark, and this allows them to withstand the fire that clears out underbrush and other trees, which would otherwise compete for limited water and nutrients. The redwoods of coastal California have a different adaptation, in the form of fireproof burls from which the tree can resprout (and which are used to make top-quality tobacco pipes).

If fire is excluded, such species struggle to survive. In South Africa's veld, for instance, well-intentioned European settlers tried to keep fire out of reserves set up to save rare plants such as the marsh rose (*Orothamnus*). The species was about to become extinct in its fireless reserve when a lightning-ignited fire jumped the fire break in 1971. The following season marsh roses bloomed in profusion.

Nor is it only flames and heat that are important. Researchers

Global estimates of annual amounts of biomass burning and of the resulting release of carbon into the atmosphere



dioxide to the atmosphere." The same is not true of fires designed to change the use of the land. Hectare for hectare, a tropical rainforest contains about 100 times more carbon than pasture.

But even if everyone agreed that prescribed burning is not going to affect the production of greenhouse gases, other problems would remain. Many of the old "fire ecologies" have long been abandoned by the people who used to manage them, or worse, so irresponsibly corrupted that it would be unwise or impossible to bring back the firestick.

Recent events around Chernobyl show how badly things can go wrong. After the reactor melted down in 1986 and released lethal concentrations of radioactive material into the air, the countryside for miles around the plant was evacuated. A landscape which for centuries had been intensively managed was suddenly left to go its own way. As fields fell fallow, flammable debris built up. In May 1992, 136 fires erupted in the region around Chernobyl, which stirred up radioactive material and spread it on the wind. The US has had similar problems with fires at the contaminated Hanford nuclear site in Washington State.

R OR LATER THE CARBON LOCKED UP IN THE VEGETATION WILL BE RELEASED INTO THE ATMOSPHERE'

Another insidious complication arises from the human habit of deliberately or inadvertently moving species around the globe. This has left many of the old fire ecologies at the mercy of aggressive introduced species such as grasses and pines, which exploit the openings created by fires to crowd out native plants. One such area is Florida's Everglades where for thousands of years regular fires shaped and sustained the ecology. Now fires have become a destructive force. According to Goldammer, "exotic invaders march hand in hand with fire", accelerating changes of fauna and flora. When imperata grasses invade rainforests after disturbances by humans, for instance, a largely non-flammable ecosystem is replaced by a less diverse vegetation that on average burns at least once every two years.

The story is similar in Australia. Before the Europeans arrived with their cats and foxes, burning off forest-floor vegetation probably created only short-term problems for native mammals. That may no longer be true in some areas. Without ground cover, native mammals make easy prey for alien predators (see "How to burn a wilderness", *New Scientist*, 29 October 1994). So if you don't burn, the bush is subjected to intense and destructive fires; but if you do, you risk losing native mammals to cats and foxes. It looks like a no-win situation.

The good news is that American foresters and ecologists have lost their revulsion for land fires. But, says Pyne, it is pointless striving for the impossible ideal of presettlement days, when American Indians and lightning regularly burnt the land. Now the land is heavily populated and developed, so the widespread, frequent, low-intensity burning of old is out of the question.

This is also true in the South African veld, Siberian taiga and various types of Australian bush. We can neither keep fires eternally at bay, nor go back to "nature's fire". Our better understanding of fire ecologies may have come too late. In many places fuel loads are so high that fires burn hot and explosively, sterilising the land instead of rejuvenating it. If the pessimists are right about global trends, we could be locked into a cycle which could make the 21st century the most flammable ever known. □

Larry O'Hanlon *is a writer from Nevada.*

at the National Botanical Institute and the University of Natal at Kirstenbosch have found that smoke helps to trigger the germination of dozens of types of plant seeds. Two chemicals in smoke—ethylene and ammonia—apparently help to awaken these seeds, says botanist Neville Brown of the University of Natal, who is trying to determine the biochemical mechanism involved.

There is even money to be made from the right kind of smoke. Brown and his colleagues have used what they have learnt about smoke to concoct handy packets of "fireless smoke", which they sell. Their chemical mixture, added to water and soaked into seeds, dramatically increases the germination success of fire-dependent seeds.

Another vital role for fires in the wild may be to keep diseases and parasites at bay. In the forests of western North America, ecologists have noticed that smoke seems to help curb the spread of dwarf mistletoe, a parasite which preys on trees and kills saplings. According to entomologist Richard Westcott of the Oregon Department of Agriculture, smoke in these forests also seems to attract certain wasps of the Siricidae and Anaxylidae families. The wasps go into a reproductive frenzy when they come across smouldering stumps, and start laying eggs. Without the stumps, the wasps seem hard-pressed to find homes for the eggs of their wood-boring larvae. Since some of these wasps may prey on populations of tree-girdling bark beetles and other plant parasites, their fate is entwined with that of the forest as a whole.

As this kind of biology emerges, the European bias against all land fires, controlled or otherwise, starts to look more naive than ever. Yet for much of this century it was precisely that philosophy which propelled governments and environmentalists to attempt to stamp out traditional fire practices in the US, Australia, Siberia and South Africa.