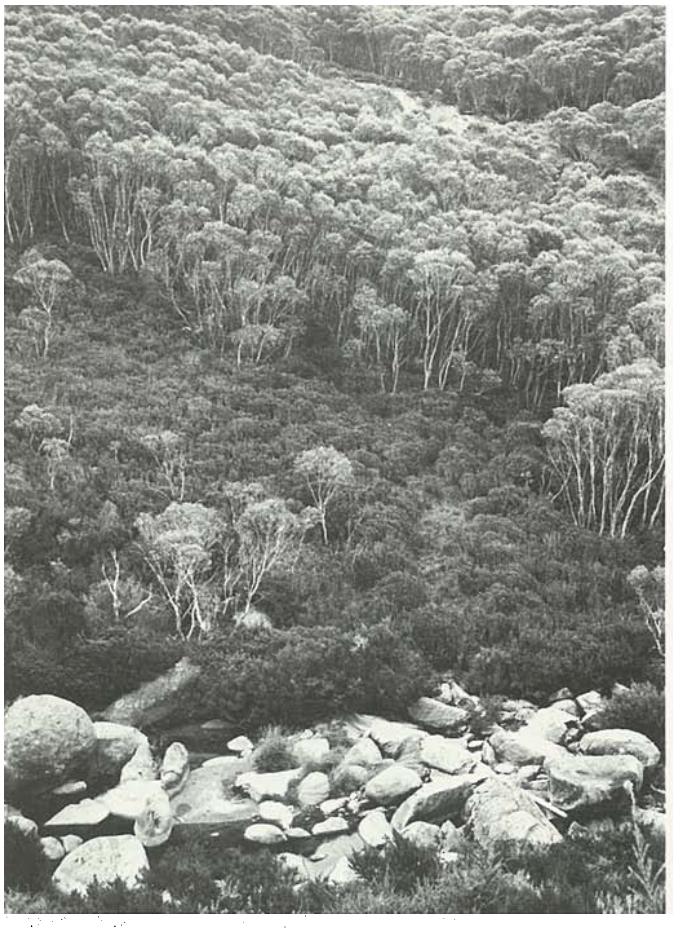
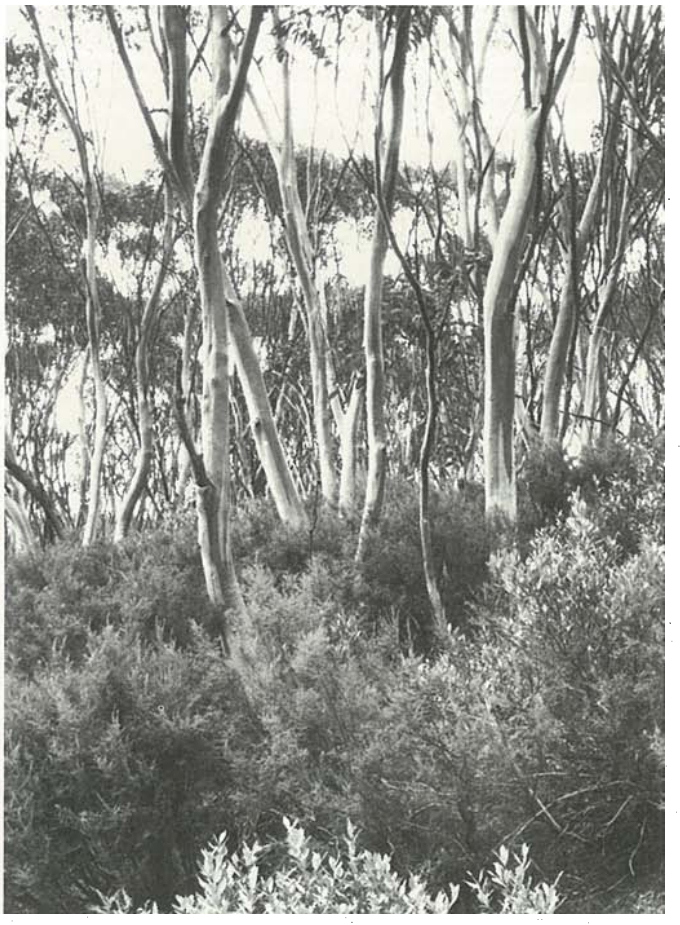


Much of the snow gum country of the Kosciusko National Park looks like this 38-year-old regrowth.



Major cause of dispute—deep *Bossiaea* scrub (and some *Grevillea*) beneath 38-year-old snow gum regrowth.

Burning question in the Snowy

In the Kosciusko National Park in southern New South Wales, prescribed burning has been in use for some years, but only in country below 1350 metres. New proposals have recently been made to burn the Park's sub-alpine snow gum woodlands up to an altitude of 1650 metres. As a result, more than three-quarters of this largest of Australia's national parks now falls into the area where prescribed burning may be carried out.

This move has raised protests from some scientists within CSIRO, and from a number of individuals and conservation groups interested in the management of the National Park.

Why should this be? Such parks are dedicated to be kept in as natural a condition as possible. Some scientists of the CSIRO Division of Plant Industry's Ecology Section suggest that it may be inappropriate to use prescribed burning in a national park. To regularly burn parts of a park may well produce a Man-made landscape that is anything but natural. They suggest that we still know so little about how fire affects the plant and animal communities in the sub-alpine parts of the Kosciusko National Park that a prescribed-burning program should not be entered into lightly.

The ecologists' queries raise questions about managing national parks all over Australia. The matter has come to a head in the high-level slow-growing alpine and sub-alpine areas of the Kosciusko National Park, partly because they have been relatively well studied and partly because the plant communities of these areas and similar areas in Victoria and Tasmania are probably among the most vulnerable to fire.

In a national park, prescribed burning may have two purposes—to consume the fuel on the ground and hence reduce the fire hazard, and to be a management tool for manipulating the vegetation. Manipulating the vegetation requires detailed knowledge of what effects fire will have.

Before we came

Fire must have always been a feature of the Snowy Mountains landscape, as it has nearly everywhere else on the Australian continent. Even before the Aborigines arrived, lightning strikes during droughts must have ensured that sizeable areas of what is now the Kosciusko National Park burnt from time to time.

With the arrival of the Aborigines the frequency of fires may have increased somewhat, since they certainly did use fire to help in hunting wildlife. However, what evidence there is suggests that the Aborigines never permanently settled the

Snowy, they merely moved up to the higher areas in summer to feast on the bogong moths that migrate there in huge numbers at that time. It's thought that little in the way of game ever inhabited the higher altitudes, so the Aborigines seem to have had little reason to deliberately burn the high country.

Things must really have changed about 130 years ago when the first European settlers moved in and used the area as summer grazing for sheep and cattle. Each autumn, as they left, the graziers set fire to the pastures, thus burning off the old rank growth of snow grass and ensuring plentiful green feed the following year.

The practice of grazing and burning combined with the occasional wildfire changed the landscape greatly. Often, opening up the snow grasses caused erosion and enabled shrubs to get established, with the result that slowly the shrubs took over. The graziers then had to burn more often to keep the shrubs in check. But more frequent burning favoured these shrubs, so the graziers became caught in a vicious circle.

The brilliant wildflower displays for which the area is renowned (see *Ecos* 10) also suffered. Some species—particularly the alpine celery and anemone buttercup—virtually disappeared. A number of grasses also became very rare. In addition, bogs in particular became eroded, partly from trampling but also because in dry weather the peaty soil itself burnt.

A profound change took place in the woodlands dominated by snow gums. At high altitudes and in frost hollows, young snow gums have little tolerance of fire. Whether or not they will tolerate any fire is very much the crux of the present dispute on the advisability of prescribed burning.

A hot wildfire will kill all the snow gums in its path to ground level, regardless of how old they are. The cooler fires that often resulted from graziers' activities frequently left the trees with the thickest bark still living, but killed all the younger trees around them.

After a fire, snow gums regrow from lignotubers—that is, provided they aren't grazed. Grazing sheep find young snow gum suckers very palatable, and the suckers don't have to be eaten off very often before the lignotuber gives up and dies. As a result many areas that used to carry snow gum woodlands don't any more. Wildfires and graziers' fires killed the trees to ground level, and sheep finished them off. Where less-intense fires had passed through, the older trees remained, but the sheep avidly ate any seedlings and suckers, so these woodlands were not renewing themselves.

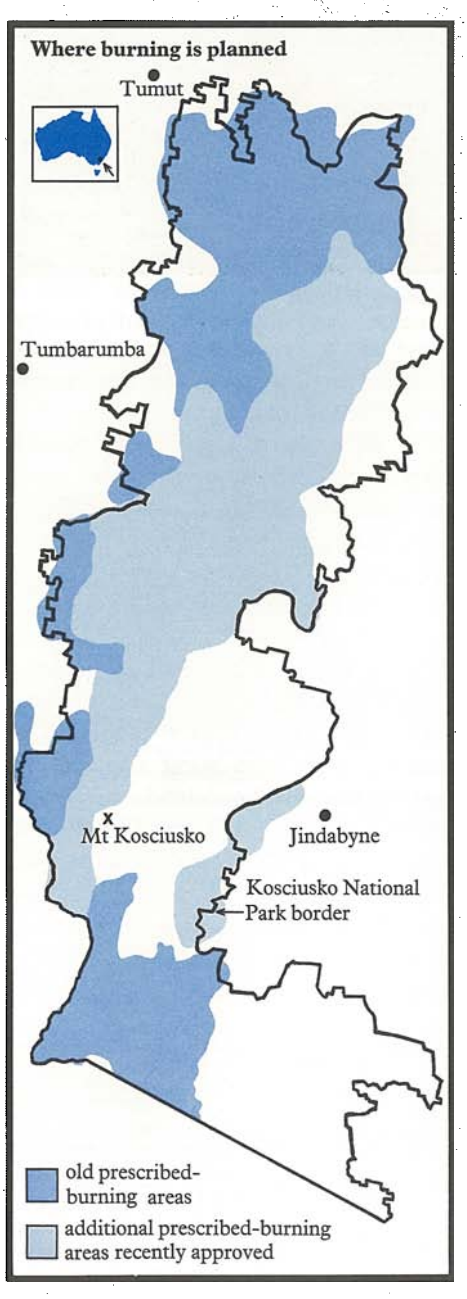
The combined interests of the Snowy Mountains Hydroelectric Scheme (practically all of which was built in the Park) and nature conservation finally brought grazing progressively to an end in the years following 1958. Conservationists were worried by what grazing was doing to all the components of the landscape, and the Snowy Mountains Authority needed clean water for its dams. Erosion would cause its dams to become silted.

Young vegetation

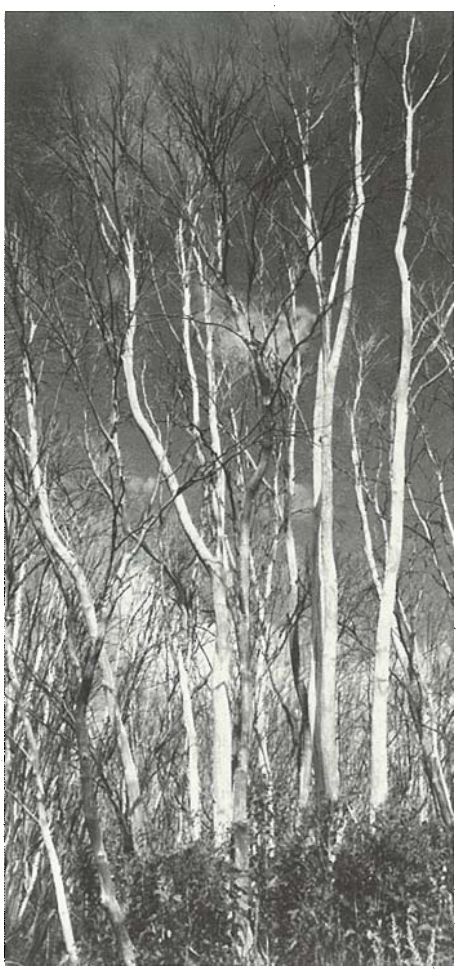
Today the vegetation of most of the Kosciusko National Park is relatively young—in fact much of it is about 38 years old. The bushfires of 1939 were massive. They burnt much of the Park area, and probably nobody wants to see anything like them again. Most of the thick snow gum woodlands consisting of mallee-like trees with many stems are regrowth from this fire. Large expanses of country that bore woodlands in 1939 are now grass or shrubland because sheep grazed the young suckers. Beneath a great deal of the snow gum regrowth a thick layer of *Bossiaea* bush (pronounced 'bossia'), some 2 metres deep, now covers the ground.

Not many people doubt the scenario presented so far. Arguments really arise when considering the future. Some could be resolved if we had more knowledge of the animals and vegetation in the area. Others depend more on the outlooks of the protagonists.

At present, the 38-year-old regrowth of the Kosciusko National Park contains a great deal of very inflammable plant litter.



The Aborigines seem to have had little reason to deliberately burn the high country.



Snow gums regenerating from underground lignotubers after a fire.

Kosciusko National Park burns during the Tumut Valley wildfire, March 1965.

Former snow gum woodland killed by a combination of the 1939 wildfires and grazing. The leguminous shrubs prevent soil erosion between the snow grass tussocks, and fix nitrogen in the soil.

In addition, the *Bossiaea* bushes under the snow gum will burn fiercely in dry weather. The park managers have the unenviable task of deciding what to do about it.

Inflammable bushes replaced

One solution is to burn off the inflammable layer during cool weather. However, the ecologists of the Division of Plant Industry have evidence that this inflammable understorey is merely an early stage in the process of ecological succession. Given time, the *Bossiaea* bush will die and be replaced by grasses and herbs that are much less inflammable.

These researchers have already observed one or two places where this seems to be happening. Also, the few remaining areas of old snow gum woodland that do not appear to have been burnt for a long time also have a ground cover of rather unburnable grasses and herbs.

Research by Dr Geoffrey Park, recently of the Australian National University, seems to support their view. He showed that, as the early stages of the ecological succession take place after a fire, the amount of plant material above ground builds up for about 40 years or so. It then drops to a lower more stable level—which is reflected in the change from shrubs to grass.

The results of both Dr Park and the Plant Industry ecologists seem to point to a period of about 40 years before the next stage of succession to grassland begins to become apparent. If this is so, then much of the area burnt out in 1939 and now near the end of the early inflammable shrubby phase should start reverting to non-inflammable grassland during the next few years.

The implication of this statement is of course that to prescribe-burn these areas would be counter-productive. And herein lies one bone of contention.

Bossiaea foliosa.

Not all the ecologists' critics would disagree with the predictions about what the vegetation will do if it remains unburnt. However, most doubt whether it will remain unburnt by wildfires long enough to let it progress to grasses and herbs. They point to the history of fires in the area. Much of the Park was burnt during the bushfires of 1939, and photographs taken earlier suggest that in 1926 extensive areas were burnt also. Lesser areas burnt in 1952 and 1965.

Each of these fires happened in times of drought during 'blow-up' conditions—with dry vegetation and soils, high temperatures, low air humidities, and strong winds. Strangely, in this century such conditions seem to have happened remarkably regularly on a 13-year cycle: 1926, 1939, 1952, and 1965. If the cycle continues, the next really major conflagration could be during the summer of 1977–78.

Most doubt whether it will remain unburnt by wildfires long enough to let it progress to grasses and herbs.

Will the Park burn out?

If blow-up conditions do occur, will uncontrollable wildfires again burn out much of the Park as happened in 1939? That prospect is appalling, but quite possibly it won't happen. For one thing the 1939 fires were unusual in that they came from country in Victoria to the south-west. Forest fires had come together on a broad front along the northern border of the State. They crossed into New South Wales on January 14, driven by very strong winds from the south-sou'-west.

Moreover, the situation has changed since 1939. Nowadays firelighting is rigidly controlled by law, and bushfire brigades have been set up. In addition, country to the north-west, west, and south-west of the Park is regularly burnt to reduce the hazard of fires sweeping in from outside. Within the Park itself the Snowy Mountains Scheme has vastly improved access to formerly inaccessible areas, and so fires can now be fought more effectively.

Nevertheless, in 1965 a large fire started in the Park and burnt 66 000 ha. Others may also start within the borders of the Park—as happened during the less severe fire season of 1972–73 when several areas, including the Grey Mare Range, were burnt.

To date, prescribed burning on the western and northern sides of the Park below 1350 metres has been carried out with few objections. The argument arises in the fragile slow-growing woodlands

A prescribed burn in snow gum at about 1350 metres in the Brindabella Range near Canberra.

Fires are unpredictable at high altitudes. This one in May 1957 burnt out the shrubland at about 1600 metres as the snow melted after an early fall.

above this level, where some burning is now planned.

Managers' dilemma

The managers of the Kosciusko National Park face a difficult dilemma. To them is entrusted the management of the Park to preserve at least the wilderness areas in as natural a state as possible. However, they are compelled by law to control all fires within the Park, and any fire that spreads outside because of their 'negligence' may create great legal repercussions. In addition, the managers must consider the water requirements of the Snowy Scheme.

It's still not certain how much stream silting results from bare ground left by wildfires. Mr Roger Good, then of the New South Wales Soil Conservation Service, studied two catchments in the area following the fires of December 1972, and his results suggest that erosion and stream siltation may not be as bad as has been feared.

The damage depends on three things: the erodibility of the catchment's soils, when the next heavy rains fall, and the time of year. Records of Wallace's Creek and its catchment, which was burnt out in March by the 1965 fires, show that the vegetation took a considerable time to recover from this autumn burn. Silt loads in the creek were massive, but the catchment consists of a particularly erodible mudstone.

Ideally, all the rain falling on a catchment should sink into the soil. During many years of research in the Snowy, Dr Alec Costin, formerly of the Division of Plant Industry, showed that beneath snow gum woodland about 23 tonnes of shrubby material per hectare are needed to make as much rain as possible percolate into the soil. (Only about 10 tonnes of herbaceous understorey per ha will produce the same effect.)

During blow-up conditions, a fire in woodlands with 23 tonnes of fuel per ha could well be uncontrollable—especially if the fuel load consisted mainly of *Bossiaea* bushes.

Bark thickness important

Prescribed burning will reduce this load —with some reduction in the water yield—but the ecologists at the Division of Plant Industry fear for what will happen to the snow gums in the woodland.

Mild fire in frosted snow grass. It will favour shrub establishment.

Firefighting in a wilderness area needs sensitivity. Many people would find a bulldozed firebreak like this one in snow gum regrowth unacceptable.

As mentioned earlier, snow gums in the sub-alpine region have very thin bark. It's the bark on a tree that protects it by insulating the growth tissues, which are located just beneath. The thinner the bark, the less fire-tolerant is the tree. Among the eucalypts that grow at high altitudes, the bark becomes thinner the higher you go.

Even so, this insulating layer does become thicker with age. The ecologists fear that the young snow gums in the new high-altitude burning blocks are so thin-barked that they won't tolerate any fire.

The issue is confused by scientific terms. Snow gums (*Eucalyptus pauciflora*) come in various forms depending on the altitude. Subspecies *niphophila* grows at the highest levels, and it looks different from other types lower down. However, there is no dividing line between the various forms; they grade into one another.

Niphophila-type trees have the thinnest bark because they grow at the highest altitudes. These will definitely not tolerate any fire, and nobody is recommending that they should be burnt. Lower down, the snow gums apparently will tolerate burning. Experimental prescribed burns carried out at 1200 metres in the Brindabella Ranges near Canberra by Mr James Hoare of the CSIRO Division of Forest Research show this. The argument is whether the intermediate forms of snow gum between 1350 and 1650 metres, some of which are very like the *niphophila* form, will tolerate fire.

Mr Alan McArthur of the Division of Forest Research, who was co-author of the new fire plan for the Snowy, and who has studied how fires behave in Australia for many years, thinks that they can.

Members of the Division of Plant

Industry disagree. They have two pieces of evidence to support their fear. One comes from the fires that burnt the Grey Mare Range in 1972. The scientists have examined an area at an altitude of 1620 metres—near the upper limit for planned prescribed burns—where the fire had very nearly died out. In some places the fire had burnt so gently that even the twigs of the *Bossiaea* bushes remained. Nevertheless, the young 39-year-old snow gum stems in the area died.

This piece of evidence is not convincing on its own—the ground was dry and the organic matter in the soil itself may have burnt and hence killed the trees. Any prescribed burning will be carried out when the soil is too wet to burn. Also, under these circumstances the trees will contain more sap and so may tolerate more heat.

The other piece of evidence comes from the ecologists' observations on a prescribed burn carried out during April 1972 in the south-western part of the Park. The burnt block included the summit of Mt Youngal. The vegetation near the summit includes a patch of snow gum woodland whose trees are intermediate between the forest form and the subspecies *niphophila*.

Before the fire, herbs and a fair amount of woody litter lay under the trees in one part of the patch, and thick *Bossiaea* bushes more than 2·5 metres high plus a heavy accumulation of fine plant litter under another.

In the area observed, the fire was a mild one. Even when consuming the inflammable shrubs it did not appear to be damaging to the snow gum canopy. In fact, a visit to the area 2½ years later revealed that where fire had burnt through the grassy understorey it had killed only scattered stems of snow gums and young mountain ash. However, where there had been a fire in the *Bossiaea* understorey all the stems had died and there was now dense snow gum regrowth some 1·5 m tall.

Obviously the way out of the argument is to try experimental burns within the Kosciusko National Park in sub-alpine snow gum woodlands with a *Bossiaea* understorey. This will now be done.

Maintaining diversity

Snow gums may dominate the woodlands in the sub-alpine parts of the National Park, but they are of course only one component of one ecosystem in the area. Even if a woodland can be burnt in such a way that the trees remain unharmed, the rest of the ecosystem—the shrubs, grasses, herbs, and animals—has still been greatly altered.

The ecologists fear for what will happen to the snow gums in the woodland.

Does this matter in a national park? These parks have been set aside mainly to conserve the ecosystems they contain. Perhaps therefore, each park should contain examples of all its ecosystems in every stage of ecological succession from the pioneering phase to the mature stable one. This will ensure that as many species of plants and animals as possible will continue to survive. Thus the aim of management is to maintain as much diversity within the park as possible.

One way to do this in an environment that evolved with fire is to carefully manipulate the whole area so that all the required diversity develops. Prescribed burning may be used as a tool to make this possible. However, it may be very difficult to avoid burning small areas that may need protection from fire. Also, the ecologists of the Division of Plant Industry question whether enough is known about the sub-alpine ecosystems to allow the manipulation required.

And what about the usually large areas designated as wilderness—should they even be managed at all? Wilderness areas are dedicated with the intention that they will receive a minimum of human interference. They should remain as 'natural' as possible, so that the animals and plants they contain can continue their struggle for existence and evolution with a minimum of human interference.

Land within two of the designated wilderness areas of the Kosciusko National Park is at present included in blocks where burns will be prescribed. It can be argued that to deliberately burn parts of them every 10, 20, or even 50 years is artificial, and therefore the technique should not be used.

Keeping Kosciusko natural

But what are 'natural' conditions? Certainly before Europeans arrived the area did burn from time to time. Nevertheless some pockets even now seem to have escaped hot fires at least for 250 years, and one tree has been found to be more than 400 years old. Nowadays human activities have greatly increased the number of fires—our existence can't be ignored. Even so some 30% of the fires starting within the Kosciusko National Park still result from lightning strikes.

Some of the CSIRO ecologists favour trying to extinguish all Man-made fires, but letting those started by lightning strikes—a natural cause—burn until they emerge from the wilderness. In this way the frequencies of fires may closely resemble the primeval situation.

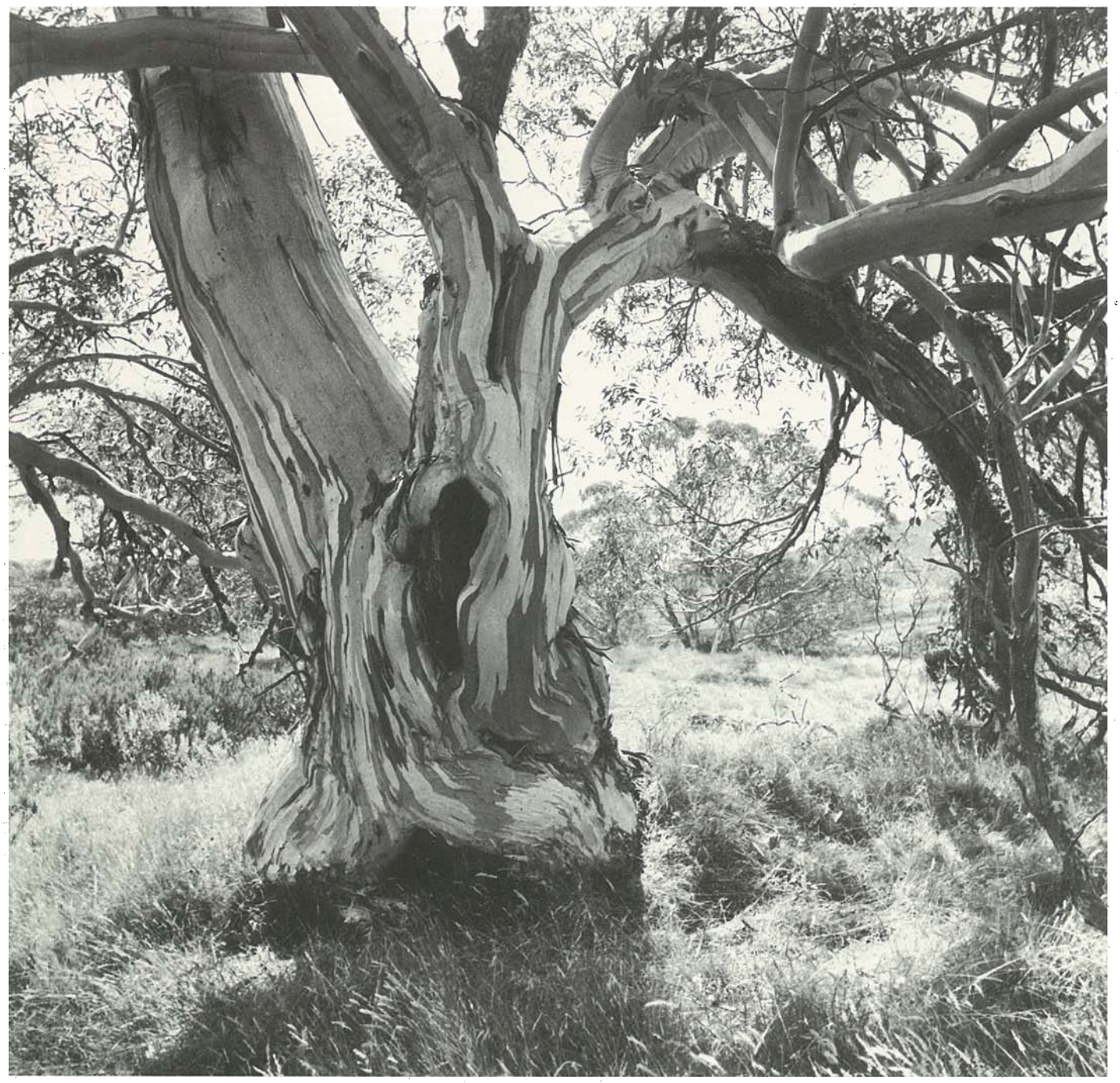
Of course this idea has its snags—people with experience of fighting bushfires maintain that it's not possible to contain a wildfire in a wilderness area, however regularly the buffer zones surrounding it may have been burnt.

And what if the 'let-burn' policy were carried out and most of the wilderness areas burnt in a 'blow-up' year? What happens to the ecological diversity then? Perhaps this may not be as disastrous as it seems. Wildfires do not consume everything before them. They die down at night, and even when raging at their hottest they leap over some areas. Thus in places trees and plants are reduced to ashes, and in others they are merely scorched. Some areas escape burning altogether. What remains is a mosaic of ecosystems at different stages of succession, so diversity remains.

If the cycle continues, the next really major conflagration could be during the summer of 1977–78.

In fact it's quite possible that during blow-up conditions wildfires would not be as serious as some people fear. Lightning strikes occur most summers, often in large numbers. During many fire seasons conditions are mild, and there is evidence that if the fires (once started) were allowed to take their course, much of the inflammable fuel in the Park would be regularly burnt, albeit quite often by fires rather hotter than would be aimed for during prescribed burns. So could it be that prescribed burning is a controlled substitute for a natural process that would occur anyway?

Disputes about fire management within Kosciusko National Park will go on as long as there are people to argue. Nevertheless, sooner or later research will resolve many of the issues, and perhaps in time others will just fade away.



Colin Totterdell pictures grass beneath an old snow gum. Most of the snow gum woodlands of the Kosciusko National Park will come to look like this if they remain unburnt for long enough.

More about the topic

Fire in Kosciusko National Park. A. M. Gill, R. H. Groves, J. H. Leigh, P. C. Price, and D. J. Wimbush. *CSIRO Division of Plant Industry Annual Report*, 1975.

Problems of management of fire-prone vegetation for plant species conservation in Australia. A. M. Gill. *Search*, 1977, **7** (in press).

Management opportunities in Australian high mountain catchments. A. B. Costin. In 'International Symposium of Forest Hydrology'. Ed. W. E. Sopper and H. W. Lull. (Pergamon Press: Oxford 1967.)

A preliminary assessment of erosion following wildfires in Kosciusko National Park, N.S.W., in 1973. R. B. Good. *The Journal of the Soil Conservation Service of New South Wales*, 1973, **29**, 191–9.

A coda: ecosystem development, forest fires and conservation management. In 'Variation in Nutrient Dynamics and Secondary Ecosystem Development in Sub-alpine Eucalypt Forests and Woodlands'. G. N. Park. (Ph.D thesis; Australian National University: 1975.)

The Snowy: conservation and water. *Rural Research* No. 81, 1973.

Fire behaviour in eucalypt forests A. G. McArthur. *Forestry and Timber Bureau Leaflet* No. 107, 1967.

The effect of grazing and burning on a mountain grassland, Snowy Mountains, New South Wales. W. G. Bryant. *Journal of the Soil Conservation Service of New South Wales*, 1973, **29**, 29–42.

'A Study of the Ecosystems of the Monaro Region of New South Wales.' A. B. Costin. (N.S.W. Government Printer: Sydney 1954.)

The vegetation of most of the Kosciusko National Park is about 38 years old.