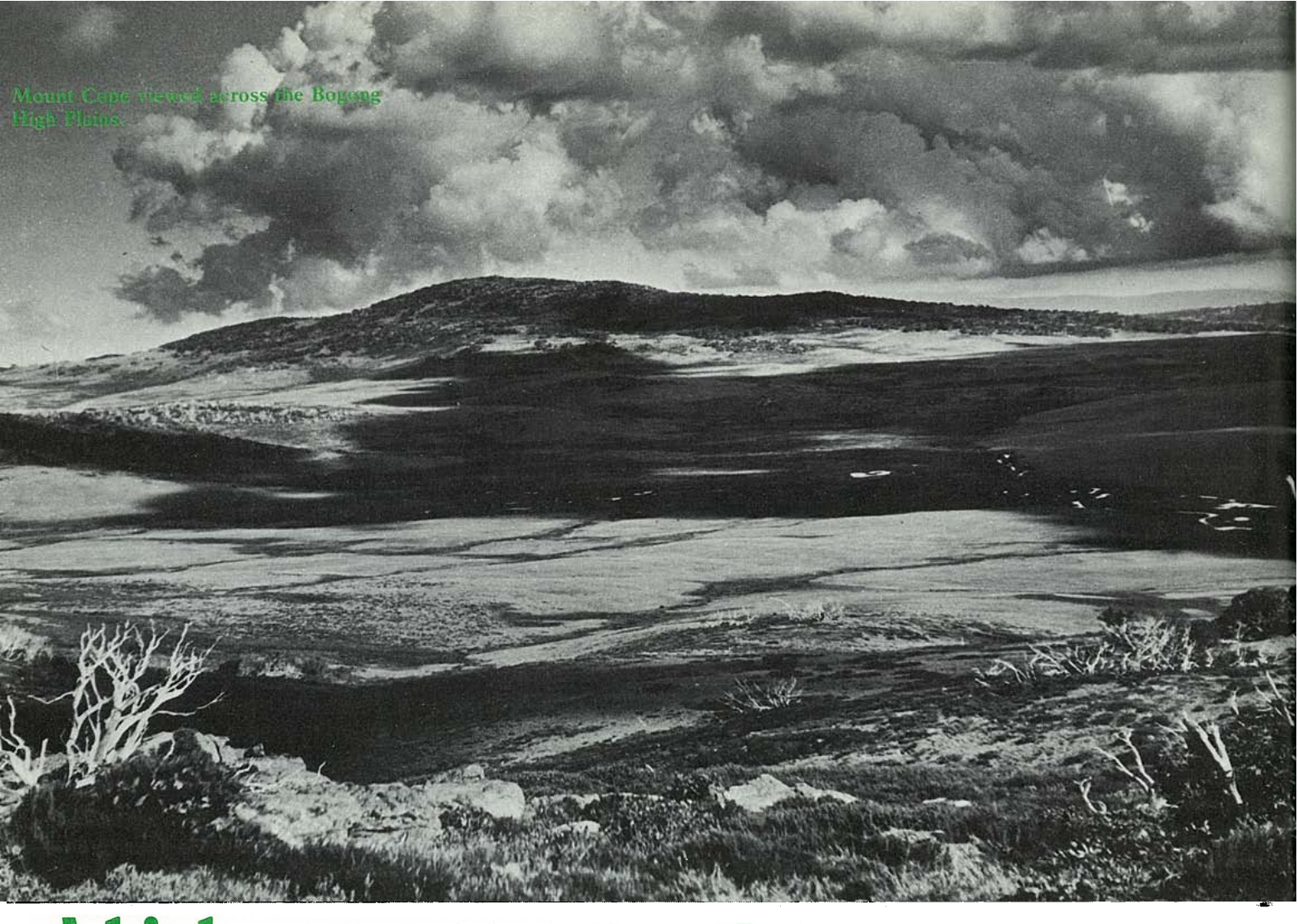


Mount Cope viewed across the Bogong High Plains.

# A high-country perspective

*by Brian Lee*

Last June, the Land Conservation Council of Victoria announced its final recommendations for the future of the State's alpine areas. Publication by the Council of its proposed recommendations 14 months previously had caused quite a furore, with the result that diverse interests within the community bombarded it with no less than 14 013 submissions commenting on these earlier proposals.

The Victorian Alpine Area is roughly rectangular, about 200 km in length by 90 km across. It contains some of the State's most impressive scenery.

For more than 40 years the Victorian National Parks Association has been campaigning for much of it to be included in a large national park, which would abut the Kosciusko National Park across the border with New South Wales. But the Association has by no means been the only section of the community with views on how the area should be used.

For example, the timber industry wants access to the alpine ash stands of the Wonnangatta Valley and elsewhere, and the area forms the catchments for the hydro-electric schemes of the Kiewa Valley, the Dartmouth Dam, and the irrigation schemes further down the Murray River. What's more, ever since its discovery by European settlers in 1853, the rolling landscape of the Bogong High Plains has been the haunt of graziers, who moved their livestock up to the area each summer. Understandably these people have been reluctant to move from what they regard as their traditional grazing land.

## Three-way split

What finally eventuated from the Land Conservation Council were recommendations that an editorial in *The Age* newspaper described as 'all too compromising'. Under the compromise, roughly one-third of the area would be allocated for timber production, one-third for national parks, and the remaining one-third would be left uncommitted. In addition, some grazing would be permitted in the three areas proposed as national parks.

As some people were quick to point out, allowing grazing runs contrary to what is usually regarded as being the purpose of a national park. It's not only that a national park, by definition, contains only native animals and plants. Over the years an impressive body of detailed scientific evidence has built up to show that grazing by domestic livestock alters Australian high-country vegetation and at times causes erosion. Much of the evidence has come from the Snowy Mountains of New South Wales, and the Victorian Alps.

## High-country studies

In Victoria, the Soil Conservation Board (now Authority) was set up in 1940. The following year, with financial help from the Board, Professor J. S. Turner and Mrs Stella Carr (Maisie Fawcett), of the Uni-

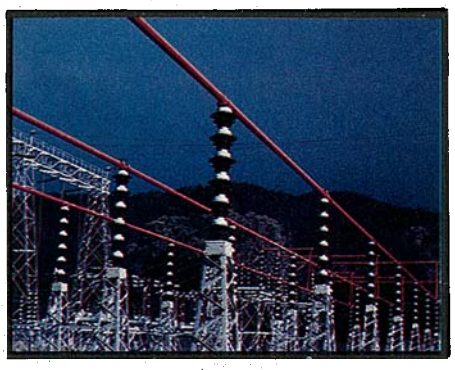
versity of Melbourne, began their long-term research into erosion on the Hume catchment. Professor Turner had first become interested in the problem in 1939.

Mrs Carr's early observations led to the Soil Conservation Board and the graziers agreeing to limit cattle grazing on the Bogong High Plains in 1946. Cattle numbers were reduced, and the annual grazing periods shortened.

During the mid 1940s, with the assistance of the State Electricity Commission, Professor Turner and Mrs Carr fenced off plots in Pretty Valley and Rocky Valley on the Bogong High Plains, and these have remained ungrazed ever since. So these plots have now been protected and observed for some 35 years. They look very different from the areas outside, where grazing by cattle has continued.

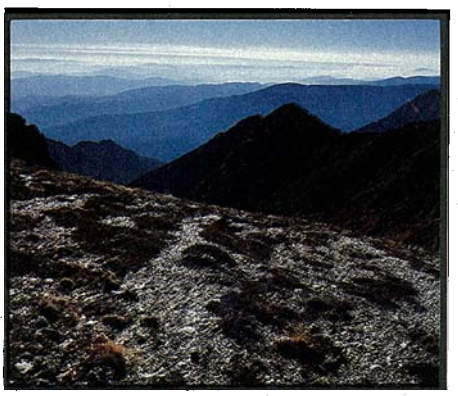
The severely eroded summits of the higher Victorian peaks were progressively withdrawn from grazing during the 1950s, and the Soil Conservation Authority has been recording changes in the vegetation on Mount Hotham and Mount Loch since grazing finally ceased in 1960. Since then, controls on grazing have been gradually extended to other parts of the Victorian high country.

**Provision of services for ski resorts like Perisher Valley needs to be planned carefully. A sewerage line laid injudiciously through a bog may drain and destroy it.**



**Electrical installations in the Kiewa Valley, Vic. Water that provides the power for the valley's hydro-electric generators comes from the Victorian alpine area.**

**Burning and grazing have turned this area of the Tasmanian Central Plateau from grassland into shrubland. An erosion pavement has formed in the foreground.**



**Sparse feldmark inhabits an exposed area that overlooks Sentinel Peak in the Snowy Mountains.**

**Boundary of the Kosciusko National Park: cattle have eaten out the flowers on the left-hand side, which is outside the park.**

Similarly, in New South Wales, the Soil Conservation Service began studying soil erosion in the Snowy Mountains soon after its inception in 1938. It was partly these studies that led to the establishment of the Kosciusko State Park (as it was then called) in 1944. In the years that followed, rising concern about protecting the area's catchments, particularly after the Snowy Mountains Authority was formed, led to restrictions on grazing and burning off.

During 1957, Dr Alec Costin and Mr Dane Wimbush, both of whom worked at that time for the CSIRO Division of Plant Industry, established fenced plots and 10 reference transects in the Kosciusko State Park. Like Professor Turner and Mrs Carr, they set out to compare the effects of the traditional grazing practices with what happened when the vegetation was protected.

At that time the New South Wales Government had just announced that most of the sub-alpine and alpine high country (that above 1370 and 1830 metres respectively) would be withdrawn from grazing during the next few years. Thus the transects would give a record of the changes in the vegetation that took place once grazing and burning ceased, while grazing experiments on the plots would give direct results, which could be extrapolated to other areas using the knowledge gained from the transects.

The two scientists located their two sets of fenced plots in the sub-alpine region at 1660 and 1700 metres height respectively. Their transects ranged from altitudes in the sub-alpine zone at about 1660 metres up to the top of the alpine zone at the summit of Mount Kosciusko. They laid these out in a pattern that crossed as many different types of vegetation as possible. Ideally, each particular type was represented several times, in various states of repair.

*Ever since its discovery by European settlers in 1853, the rolling landscape of the Bogong High Plains has been the haunt of graziers.*

It's hard to fault the detail of the information that Dr Costin and Mr Wimbush gained from the transects. They began making observations of the vegetation along these permanent lines across the landscape in 1959 at points 305 mm (12 in.) apart. They cut these intervals to 152 mm (6 in.) along the alpine transects in 1961, and along the sub-alpine ones in 1964.

Between 1964 and 1978 they therefore managed to make repeated detailed observations of any changes in the vegetation at no less than 9108 fixed points along the transects in the sub-alpine region, and at 5940 points in the alpine one — which makes a grand total of detailed observations on 15 048 fixed points 6 in. apart over a 14-year period. For the 19 years from 1959 they also have observations on 7600 points 12 in. apart.

### Snow grass avoided

The first important result to come out of the grazing trials was one that other

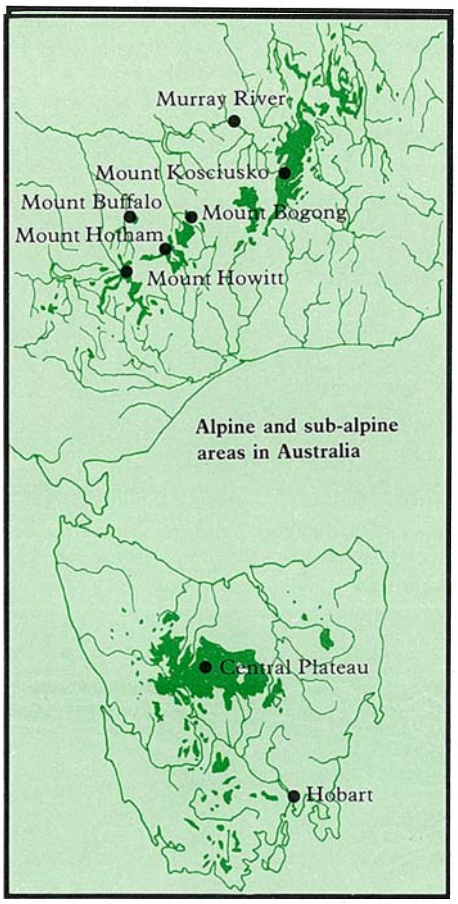
people had already reported — that on a snow grass sward, grazing animals (in this case sheep) were having more effect than one might expect. Only very rarely did they graze more than the seed heads and any young shoots on the snow grass tussocks. Instead, they concentrated on the softer more palatable herbs that grew in the tussocks and in the spaces between them, so these herbs were being grazed much more heavily than might at first have appeared.

This habit of grazing selectively, which cattle and rabbits share, has very important implications for alpine and sub-alpine areas — be they in the Kosciusko National Park, the Victorian Alps, or the Central Plateau of Tasmania. It means that the animals will go for the wildflowers, like the billy buttons, for which the Kosciusko National Park is so well known. It also means that, in extreme cases, the spaces between the snow grass tussocks may become completely bare, as has happened over large areas of the Tasmanian Central Plateau. Serious soil erosion may then get under way.

(It means too that allowing cattle to graze in the Kosciusko National Park during droughts — as happened in 1972 and 1976 — will have more effect on the vegetation than one might think. The animals will concentrate on the already stressed herbs between the tussocks.)

### Progression to shrubs

The way in which grazing alters alpine and sub-alpine grasslands can be regarded as a series of steps. To begin with, the livestock graze the larger perennial herbs, which often cannot take the pressure. Then, grazing-resistant minor herbs, like clover or sorrel, replace them. Thus the grassland may be converted into an apparently stable sward of snow grass tussocks with quite desirable (from a grazing point of view) minor herbs in the spaces in between. The problem is that erosion may begin, as the minor herbs do not provide enough protection from frosts, winds, and water from rain or melting snow.




**Daner's Gap, Kosciusko National Park. A stony erosion pavement has formed in the foreground, and shrubs have taken over on the thinned soil behind.**

What happens next depends on the type of vegetation that exists nearby. Where a treeless grassland covers a broad and fairly level plain, it may alter little for many years, although erosion may break out on any slopes. However, if any shrubs grow in the neighbourhood, their seeds will be able to germinate in the relatively open inter-tussock spaces, establish seedlings, and spread out, with the result that the grassland becomes a shrubland.

Unfortunately the traditional practice of burning the grasslands, particularly those beneath the prized sub-alpine woodlands, helped this progression along. In the early days the high-country stockmen burnt the snow grass swards with the aim

## Readers beware!

The relations between the different types of vegetation in Australia's high country are very complicated. The reader should bear in mind that this article describes general principles that show how the vegetation in these regions reacts to different forms of land use. Of course governments must also take social, political, and other factors into account when decreeing the uses to which the highlands may be put.

While the ecological principles described here apply in general to alpine and sub-alpine parts of New South Wales, Victoria, and Tasmania, anybody who knows these areas will be able to think of exceptions. What's more, there are differences between the three highland localities, so each presents different exceptions.

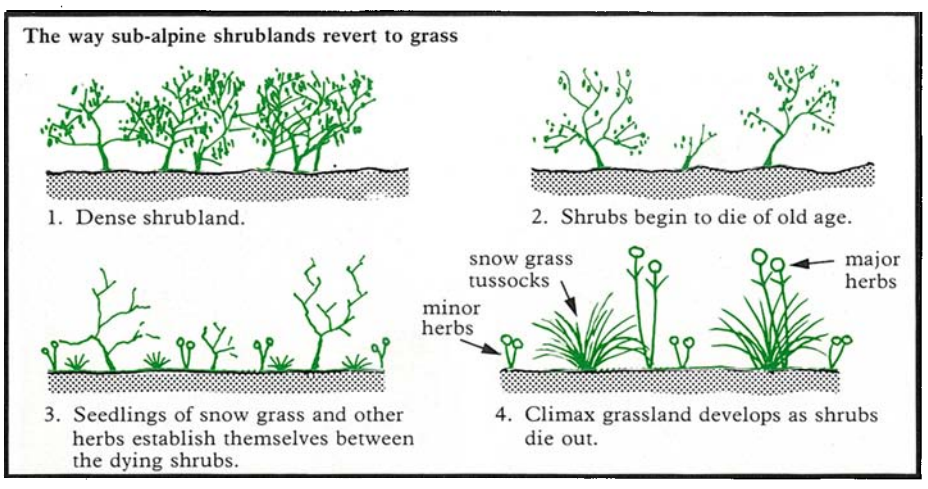
These exceptions do not, however, mean that the general principles do not apply. Unfortunately, it is impossible to discuss the exceptions in an article a few thousand words in length.

Some differences between the high-country areas of New South Wales, Victoria, and Tasmania include:

- slight variations in the environment connected with their different latitudes and altitudes
- differing histories of land use

Parts of the Tasmanian Central Plateau and the Snowy Mountains outside the Kosciusko National Park, for example, are still regularly burnt as well as being grazed. Historically, the Victorian highland grasslands appear not to have been burnt to the same extent, and deliberate burning of these grasslands has not been permitted since 1947.

In addition, although over the years both cattle and sheep have grazed all of the Australian high country, sheep have predominated in Tasmania and New South Wales, while in Victoria cattle normally predominated. Large numbers of sheep were occasionally moved up to the Bogong, Dargo, and other high plains during the first half of the century, but only during periods of extreme drought.




**At sub-alpine altitudes, disturbed areas will revert from shrubland to grassland if left alone — provided enough soil remains.**

*The thickness of the topsoil is the feature that governs whether the mature vegetation consists of grasslands or shrubs.*

of burning back the old tussocks to stimulate them into producing palatable young shoots and to encourage herbs to grow between them. (Burning the tussocks lightly doesn't kill them.) But as time went on shrubs began to invade. The shrubs that slowly took over were adapted to fire — even though many of them, such as the 'kerosene bushes', were themselves highly flammable. Burning the bushes merely burnt them back to ground level, whence they vigorously sprouted once more.

### Burn and burn again

Today's high-country stockmen say that burning stops the shrubs taking over. Their stock can obtain feed from the grasses and herbs that grow in the spaces between the burnt bushes, which indeed they do. But the shrubs crowd out the grasses and herbs after some years, and have to be burnt again. At the same time the shrubs can spread into grassland still unaffected by bushes, as their seeds can germinate in the burnt spaces between the grass tussocks. (Wildfires, incidentally, cause similar effects.)

Thus, although the practice of regular burning keeps the shrub cover on already-colonized areas sufficiently thin for some feed to be available, ultimately much of the grassland becomes covered with shrubs — a situation that already exists on most of the former grasslands of the Tasmanian Central Plateau. There, the once very extensive grassy plains are now largely covered with shrubs.

In general, on the Victorian high plains (where burning has not been allowed since 1947), and on the few remaining high-country areas of New South Wales outside the Kosciusko National Park, this progression hasn't gone so far. Here most of the grasslands still contain snow grass tussocks, but the once-plentiful major herbs that used to grow with the tussocks have become rarer. However, the shrubs are taking over in most of the open snow gum woodlands.

### No simple answer

Which brings us to the crucial question of whether the process of alteration of the alpine and sub-alpine grasslands is reversible. Certainly parts of the fenced-off plots in Pretty Valley and Rocky Valley, and other areas on the Bogong High Plains and in the Kosciusko National Park that are now protected, do seem to have changed spectacularly. Nevertheless, close study of the high country reveals no clear-cut answer to the question. Sometimes it's yes, and sometimes it's no. It depends on the circumstances.

The research of Dr Costin, Mr Wimbush, Professor Turner, Mrs Carr, and others has revealed very clearly that the Australian high-country vegetation is anything but simple. Rather, the plants growing in these areas live in a continuous state of flux. If some disturbance such as a fire sweeps through, the plant species that grow in the blackened remains may be different from those that were there before. As elsewhere, the natural vegetation may pass through a succession of stages, each stage giving way to the next as the dominant plants in each die of old age. This process of succession is slightly more complicated at the highest alpine altitudes than at sub-alpine ones.

At sub-alpine altitudes where the land has remained undisturbed for a very long time (100 years or more), the vegetation at ground level will be one of three types — grassland, shrubland, or bogs and fens.

The grasslands, which are dominated by snow grass, occur where there is a deep layer of topsoil. Trees (mainly snow gums) may grow above them on the hillsides, but in the frost hollows (see *Ecos* 12) and in more exposed places trees can't get a hold.

In the undisturbed situation, shrubs dominate rocky outcrops and other areas that lack topsoil.

Bogs and fens dominated by sphagnum moss and *Carex* sedges have formed in the wet valley floors by accumulating peat in the stream beds over thousands of years. An undisturbed bog consists of a thick mat of soggy peat that never dries out, even during the longest drought. Bogs are extremely vulnerable to any disturbance — such as putting sewerage pipes through them when servicing ski lodges, driving vehicles into them, or being trampled by stock. Often, once a drainage line has formed within it, a bog will dry out and be lost.

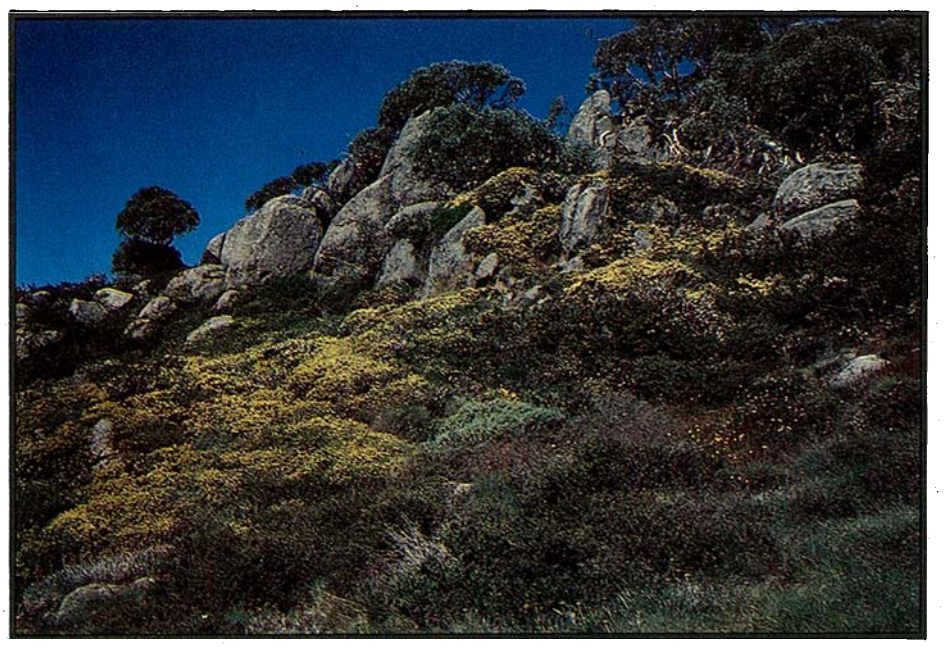
### Topsoil the crucial factor

Except in the wet areas covered by bogs, the thickness of the topsoil is the feature that often governs whether the mature vegetation consists of grasslands or shrubs. So the reversibility of any changes that have been brought about by human use depends on how much topsoil remains.

Obviously, in the extreme (but rare) case where erosion has been so serious that only bedrock is left, there will be no vegetation — other than a few small shrubs that have managed to get a hold in pockets of soil caught in the rock.

Where some topsoil still remains, shrubs will dominate — possibly permanently, depending on the conditions. But if little topsoil has yet moved, snow grass tussocks interspersed with the larger herbs like the well-known billy buttons will, in time, come to dominate once more.

In alpine and sub-alpine Australia the vegetation always moves, if not disturbed, towards a climax ground cover of perennial grasses and other herbs, provided enough topsoil remains to permit it. However, if many shrubs have already



At sub-alpine altitudes spectacular flowering shrubs, such as the yellow *Kunzea muelleri* shown here, provide the natural cover around rocky outcrops and in other places where the soil is thin.

**Natural cycles in the alpine herbfields: in November 1971 (top) white *Neopaxia* and yellow billy buttons gave a colourful display. By November 1978 (bottom) snow grass tussocks had taken over.**

managed to establish themselves, the immediate result of protecting the area will be that the shrub cover will increase. Grasses will only succeed in gaining the upper hand when the shrubs die of old age — a fact that Mrs Carr reported as far back as 1962.

Shrubs are an important stage in the succession to snow-grass-covered grassland and herbs because, in Mrs Carr's words, 'they act as nurse crops for the regeneration of snow grass'. Her point here is that snow grass just cannot colonize bare ground. Its seeds just cannot get established under such exposed circumstances. The seedlings can only develop where other plants provide sufficient protection from frosts, wind, and sun.

Among the herbs, only the major ones can provide sufficient protection. The minor ones that exist between the tussocks when grazing is taking place aren't adequate, so no new tussocks grow.

From a grazier's point of view this may look like being a good thing. However, snow grass tussocks aren't immortal and, like all other living things, they grow old and die. Thus, in time, the spaces between the tussocks become bigger. A healing layer of shrubs will allow new snow grass seedlings to grow. Thus the shrubs act as a scab on a wound.

The shrubs, of course, are a nuisance to the grazier since they reduce the amount of feed that is available. They will also be regarded with apprehension by bushfire control authorities (see *Ecos* 11). But when the shrubs die of old age, snow grass plants will once more already be growing beneath them. Seedlings of the shrubs, which need open ground to establish

**At the highest altitudes, large areas of snow grass die from natural causes from time to time.**

themselves, won't be able to compete. The observations of Mrs Carr in the Victorian Alps and Dr Costin and Mr Wimbush in the Snowy Mountains suggest that it may take about 50 years for the shrubs to begin to die off.

## Erosion pavements

If use of a grassland has been such that serious erosion has set in, two things may happen. In the worst circumstances all the soil will continue to wash away, even if the land is protected from further abuse. It will go on eroding until only bedrock remains. Obviously, once this has happened, the eroded area is beyond redemption — unless of course a public utility goes to the expense of physically spreading more topsoil on top of the exposed bedrock. Usually, however, not all the soil does erode away. Instead, a feature known as an 'erosion pavement' forms.

In most alpine and sub-alpine areas the undisturbed topsoil does not merely consist of minute soil particles. Instead, small and not-so-small stones are embedded within it. Erosion by frost, wind, and water carries away the fine grains of the soil, but not these larger stones. Thus, as the top layers of the soil erode, the pebbles and rocks become more concentrated. Ultimately, these stones concentrate into a layer consisting almost exclusively of stones. This is the erosion pavement. Erosion can then proceed no further.

## Rocky seed-bed

From a plant's point of view, the difference between this and bedrock is that some topsoil may still remain beneath the layer of stones. If the plant's root system can reach this soil, then it will be able to grow.

In fact the coarse stones of an erosion pavement will provide protection for any seeds that reach it. Thus, paradoxically, the stones of the erosion pavement then actually act as a seed-bed for shrubs, whose seedlings can get themselves established in relatively exposed situations. So, once an erosion pavement has formed, the now-stable ground is colonized by shrubs, which become rooted in the soil beneath the pavement. The long haul back towards the snow grass climax has begun.

Generations of shrubs will have to grow on the site before the snow grass can move in — considerable quantities of topsoil

will first have to accumulate above the layer of stones. So shrubs may remain as the dominant cover for hundreds of years.

This may sound rather theoretical. However, the CSIRO scientists have actually observed these changes on several of their transects in the sub-alpine areas. Even after grazing and burning ceased, some bare patches continued to enlarge until erosion pavements finally formed. But once this happened shrubs grew on the pavements and the formerly eroding areas finally became stable. Indeed, many came to look attractive, since most of the shrubs flower spectacularly.

### The alpine sequence

So much for how the vegetation recovers at sub-alpine altitudes. In the higher alpine areas a similar sequence of events occurs, but the greater exposure to cold and late-lying snows cause differences.

As in the sub-alpine regions, the dominant cover for areas well endowed with topsoil is snow grass, although the proportion of other tall herbs in the sward tends to be rather higher. Alpine ecologists therefore refer to this climax vegetation as 'tall alpine herbfield'.

In not-too-exposed rocky areas at the highest altitudes short shrubs dominate — a situation similar to that at sub-alpine altitudes. However, the really exposed saddles, slopes, and plateaux of the Snowy Mountains are the home of feldmark — a Scandinavian term for the communities of sparse and exceedingly tough little plants that grow in these places.

Although very tough, the plants that make up the feldmark communities are also very vulnerable to mechanical disturbance (such as from four-wheel-drive vehicles) or to the stamping of tourists' feet. It's all they can do to hang on in the adverse environment that they inhabit. In the Kosciusko National Park, the Park management has found it necessary to restrict people's movements to protect them.

**This stream line is becoming wider. It is also draining the bog through which it is running.**

**Groups of bushwalkers make a mess of bogs. Bridges being installed in the Kosciusko National Park will enable people to cross bogs without destroying them.**

**Tall alpine herbfield at its glorious peak.**

**Frost heave: the needles of ice have lifted the bare soil.**

The transects of Dr Costin and Mr Wimbush have revealed that not all the feldmarks in the Snowy Mountains are natural. Grazing ceased on the Gungartan area 20 years ago. Today some of the feldmarks there have begun to change into alpine herbfields. Others have not, and never will.

The two scientists now realize that the 'secondary' feldmarks that are currently changing represent an earlier stage in the succession to tall alpine herbfields. Thus these secondary feldmarks can be regarded as alpine equivalents of the shrub stage that occurs lower down. Similar ones occur on eroded parts of Mount Hotham, Mount Loch, and other peaks in the Victorian Alps.

### Wildflower displays

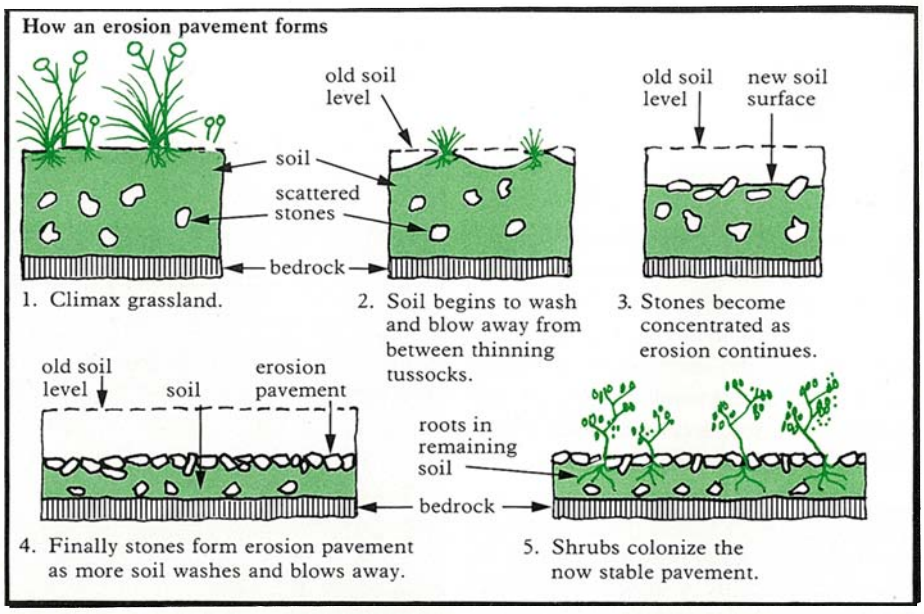
Another surprising discovery came from the transects that cross the alpine grasslands and herbfields. During mid summer, Mount Kosciusko and the other high peaks of the Snowy Mountains have long been a magnet for tourists, who journey there to see the spectacular wildflower displays. These displays vary from year to year in their showiness, sometimes for obvious reasons (such as a very dry spring and early summer), and sometimes for seemingly unaccountable ones. By chance the layout of the transects has shown the reasons why.

While grazing ceased over much of the Kosciusko National Park in the few years following 1958, all sheep and cattle were banned from the area around the summit of Mount Kosciusko when the State Park was proclaimed in 1944. Thus by 1957, when Dr Costin and Mr Wimbush put in their transects, this alpine area had already been protected for 13 years, while the rather similar Gungartan area had not.

The condition of the plant communities on the two peaks looked somewhat different — in spite of the apparent similarity of the two environments. The researchers therefore assumed that the more diverse vegetative cover of Mount Kosciusko had recovered to considerably nearer the stable state of ungrazed alpine vegetation than that at Gungartan. Therefore, they reasoned, it would change considerably less than that at Gungartan once this too became protected after 1958.

Their observations of transects located on the two alpine areas have, in general, confirmed this thinking, but they have also revealed that the composition of the apparently stable 'mature' tall alpine

**Erosion pavements form when erosion concentrates stones embedded in the soil. Usually a sparse cover of shrubs or minor herbs (not shown here) remains as erosion proceeds.**




herbfields does not by any means remain static.

At Gungartan, the wildflower displays have recovered remarkably — particularly those of the billy buttons (*Craspedia* spp.). These yellow-flowered species were barely recorded on the transects at Gungartan during the first few years. But by 1978 they provided 13% of the cover on the more exposed transects — a density adequate to provide a spectacular display in summer.

Other major forbs (herbs other than grasses) showed similar trends. In addition, while the number of species of plants remained fairly constant on the stable sites of Mount Kosciusko, the number of species of all the larger forbs increased considerably at Gungartan.

### Enigma variations

Although, on the more stable areas on Mount Kosciusko, the total number of species in the tall alpine herbfields didn't seem to change much, the amount of ground that each species covered varied considerably over the 20 years of observation. Apparently, many species go through cycles in the proportion of ground cover they provide.

Some of these cycles seem to be long-term, and are apparently connected with ageing of the snow grass and with subsequent colonization of the dead tussocks by other herbs. Some are short-term, and obviously connected with the weather conditions and other environmental factors during any particular season. These short-term fluctuations mainly affect the herbs other than the grasses.

Take the long-term fluctuations first. Snow grass appears to be the dominant plant in the climax vegetation in the alpine areas well endowed with soil. One may therefore expect that in time it will squeeze out all the flowering herbs that inhabit the spaces between its tussocks. This would lead to a boring landscape consisting only of snow grass tussocks and a few wildflowers. In practice this doesn't happen. Instead, the snow grass tussocks themselves grow old and die, thus providing space for the more spectacular herbs.

## Bogs — too fragile to be tampered with

Not many people get excited about Australia's high-country bogs and fens, yet these soggy areas of peat are a fragile resource that could be all-too-easily lost.

Way back in the 1920s, the late Dr Baldur Byles, whose reports did much to stimulate the establishment of the Kosciusko State Park in 1944, noted that stockmen in the Snowy were pointing out to him again and again 'swamps and creeks which were formerly impassable but where now a man can ride without any danger of sinking'. In this case, stream lines forming in the bogs as a result of trampling by cattle and sheep must have been a major cause of this drying out.

The trouble is that a drainage line, once formed, nearly always erodes and cuts deeper into the bog, which then dries out. As the water level drops, the sphagnum moss and other bog plants that need very wet conditions die. In the end the bog turns into nothing more than a shallow valley, along the bottom of which runs an open stream. Anybody with an untrained eye would never know that here, not so long ago, was a bog. Rather, he or she would assume that the valley had always looked like that, and that it remained in its natural condition.

Conservationists value bogs because they are an intrinsic part of our national heritage. They are also of value to the water engineers who manage the dams of the hydro-electric and irrigation schemes that depend for their water on the alpine and sub-alpine parts of New South Wales, Victoria, and Tasmania. The detailed research of Dr Costin and Mr Wimbush has shown that bogs have a big effect on the water production from these areas.

Protecting bogs from trampling by placing them in a national park is not always enough. They are still vulnerable to other human activity — such as ski resort development. A sewerage line laid through a bog, or even the wheel tracks left by a contractor's vehicle, may start the drainage process as surely as a deliberately dug ditch.

Nevertheless, at the highest altitudes the wet areas will begin to recover with proper protection — as indeed they have already begun to do in the Kosciusko National Park.

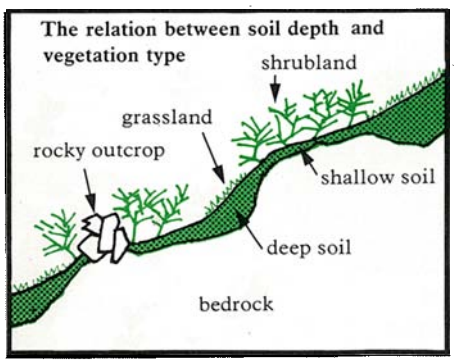
Restoring bogs will probably best be done by starting with the small drainage lines at the top and then working downstream. In this way the water at the top end can be spread over a relatively large area, thus reducing the speed and the eroding power of the stream flow lower down. With the slackened flow it may then be possible to work down towards the most eroded beds at the lower end. Obviously, repairing such bogs will take a long time, and be expensive.

Nevertheless, Mr Graeme Warboys, the ranger naturalist of the Kosciusko National Park, hopes to make a start. He plans to place sand-bags in the small stream beds in the highest part of some bogs to dam their flow. It remains to be seen how long it will take for even the smallest drainage lines to disappear.

On the transects around the summit of Mount Kosciusko the density of the snow grass cover generally decreased during the first 10 years of the CSIRO observations and then increased again for the following 10 years. Indeed, on sheltered slopes and flats near Mount Kosciusko, the proportion of cover made up by snow grass dropped from 80% at the beginning of the observation period to as low at 30% in 1968, at the end of a lengthy drought, before recovering. Similar fluctuations happened on the more recently grazed Gungartan slopes, but in a much more muted form.

### Alpine daisies benefit

The beneficiaries of this dying off on the Mount Kosciusko transects were the spectacular alpine daisies (*Celmisia* sp.) on the sheltered slopes, and the mat-forming *Neopaxia* on the flats. (*Neopaxia* normally lives just below the bare patches left by late-thawing snow drifts, where the much taller snow grasses and tall herbs cannot get established.) The proportion of the ground covered by both *Neopaxia* and the snow daisies peaked in 1971, after a run of good seasons had allowed them to occupy the mulch of dead snow grass tussocks.




**Where the soil is thick enough, snow grass and herbs grow on all undisturbed areas. Shrubs dominate naturally where the soil is thin.**

Although the snow daisies may have reached their zenith in 1971, the levels of these flowers and most other herbs in the area varied considerably from year to year. Thus the herbs appeared most prolific during the summers of 1958–59, 1963–64, and 1970–71. They reached their lowest ebb during the summers of 1959–60 and 1960–61, 1967–68, and 1977–78.

Different weather patterns seem to have accounted for most of these short-term variations. The culmination of a run of dry seasons during the summer of 1967–68 has already been mentioned. The 1958–59 growing season followed a winter with exceptionally heavy and late-lying snow. What's more, plants like the snow daisy seem to need plentiful spring rain to wash a coating of slimy fungus off their stems before they can grow. Spring rain was in short supply that year.

The summer of 1977–78 included an exceptionally dry February — the month when much of the alpine growth usually occurs. The billy buttons, which provide the spectacular yellow carpets of flowers for which Mount Kosciusko is renowned, are particularly vulnerable to such conditions — they are among the first to wilt during hot weather, and their tops dry off if rain doesn't fall frequently throughout the summer.

*If protected, the alpine areas cannot become boring uniform swards of snow grass that need stirring up by Man.*

Other influences in the environment as well as the weather affect the plants in the stable alpine vegetation cover. Insect attack, for example, can in some years cause considerable devastation to limited areas.

### Implications

Dr Costin and Mr Wimbush point out that the implication of these findings is clear. If protected, the alpine areas cannot become boring uniform swards of snow grass that need stirring up by Man from time to time to maintain their diversity. Instead, the stable cover can be better likened to a patchwork quilt. As each area within the patchwork reacts to different seasonal conditions, it becomes a continuously changing set of variations on the theme provided by the array of plant species that exist in the mature cover. Superimposed on these variations are the longer movements provided by the ageing and regeneration of the snow grass.

Thus, in the view of Dr Costin and Mr Wimbush, the alpine environment is one that will always remain an immensely rich symphony of subtle variations. It has no need of help from Man.

### More about the topic

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**The same place near Daner's Gap in the Kosciusko National Park in 1959 and in 1978. After 19 years of protection, shrubs have invaded the formerly bare areas, but the snow grass that occupied the area to the left of the nearest boulders still remains.**

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