· SOIL CONSERVATION SERVICE OF NSW ·

ABOVE THE TREELINE

HOW THE HIGH COUNTRY WAS RESCUED

One of the most spectacular and valuable resources in Australia is the alpine region of New South Wales, 500 km south-west of Sydney. Apart from its scenic and ecological beauty, this country is important for its water and recreational resources. The alpine region supports unique forms of vegetation which have adapted to a harsh and severe climate. At 2,000 metres above sea level it is the highest catchment in Australia, providing plenty of clear water for hydroelectric power and irrigation.

A serious threat to the high country, to both its alpine and sub-alpine components, was posed early this century by grazing. Sheep and cattle ate out the edible grasses and wildflowers and stockmen burnt the remaining vegetation to encourage new growth. This led to severe soil erosion. High winds, frost and running water acting on the bare exposed soil accelerated the damage. After more than a hundred years of grazing, the problem was so critical that in 1938 the region was declared an area of erosion hazard.

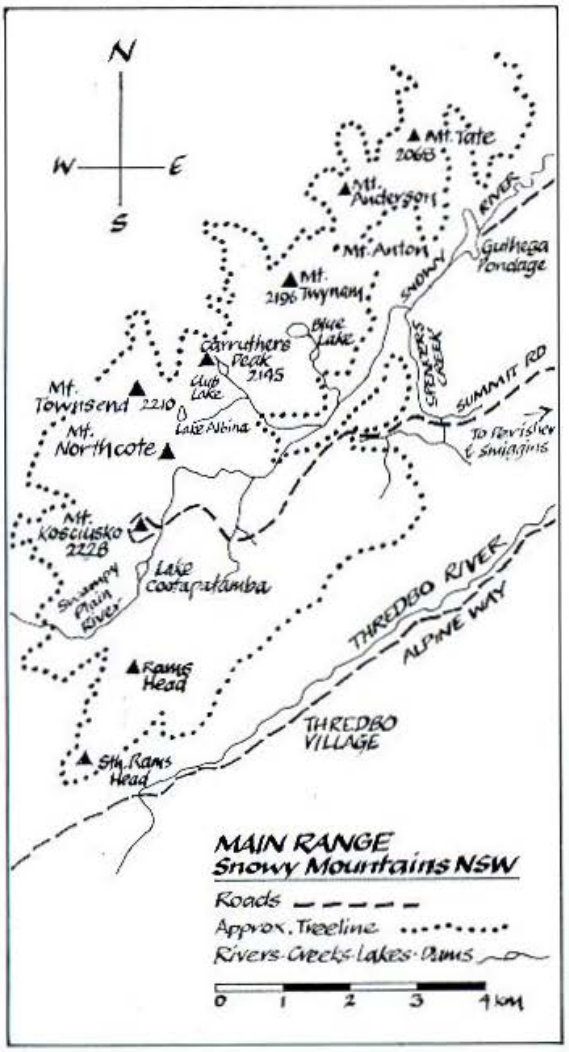
The New South Wales Soil Conservation Service is responsible for the protection and conservation of the State's soil resources. The Service's objectives are to prevent and control soil erosion and to reclaim eroded lands throughout New South Wales. In 1957 a twenty-five year program to restore the devastated alpine land was commenced by the Service. Between 1957 and 1983 over $730,000 was spent by the Soil Conservation Service in repairing the damage. Further contributions were made by the National Parks and Wildlife Service.

The alpine region has often been the scene of controversy between groups with competing interests, such as conservationists and graziers. At present, further pressures are being placed on it by the increasing numbers of summer and winter visitors.

The highest catchment in Australia has some spectacular scenery (Photos: National Parks and Wildlife Service).

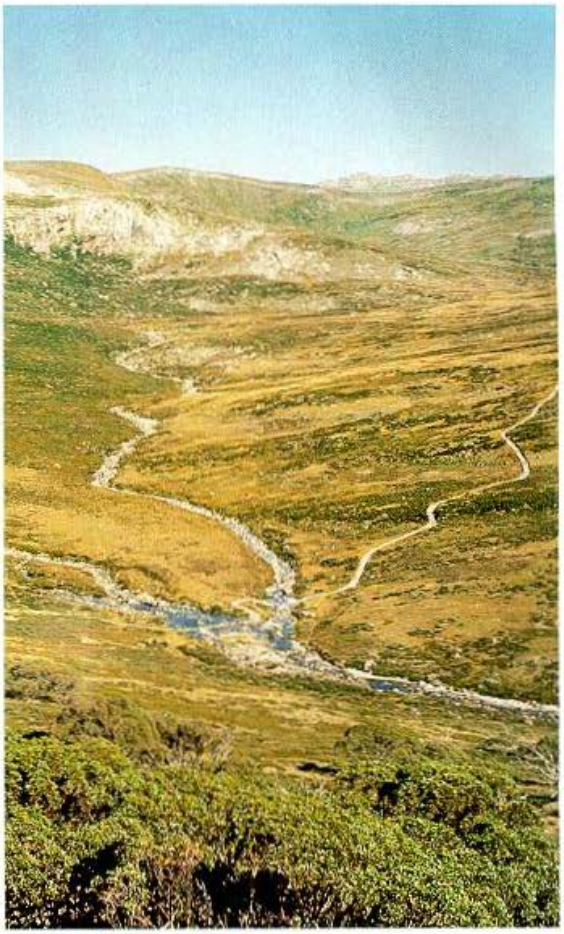
THE ALPINE ENVIRONMENT

The term "alpine" refers to those areas above the climatic limit of tree growth (at 1,800 m in Australia) but below the nival zone which is permanently covered by snow and ice. The alpine region is characterized by stunted shrubs, grasses and annual herbs in summer, which are blanketed by snow in winter. Treeless valleys are also found below 1,800 metres, close to the Main Range, because cold air collects in the depressions and produces "frost-hollows". The alpine environment is one of the most vulnerable in the mountains because its harsh weather only allows a short growing season for plants and creates conditions which can easily lead to erosion.



The summit area of New South Wales showing the location of the treeline.

Climate



Unlike the European Alps the Kosciusko area is relatively level with no sharp peaks.

Australian alpine areas contain relatively level high plains with cirques and U-shaped valleys that indicate previous mild glacial activity some 10,000 to 30,000 years ago. The weather is severe, with the alpine area having a continuous snow cover for at least four months of the year (June-September). Frosts are frequent – on average there are only ten frost-free days a year on Mt. Kosciusko. The average temperature in January is about 10°C and in July about 1.6°C. The Main Range runs almost north-south, and hence cuts across the westerly moisture-bearing sub-antarctic weather systems. This means that there are large differences in the amount and persistence of precipitation on different aspects. The western face of the ranges are much wetter than the eastern slopes. In the Kosciusko area, precipitation can be up to 3,000 mm a year and is highest in winter and spring. Wind velocities are high, reaching up to 150 k.p.h.

Soils

Unlike other areas of similar altitude in the world, the Main Range has a substantial depth of soil. There is a strong relationship between the occurrence of different soil types and physical features. Alpine humus soils are found mainly on freely drained slopes, while bogs and peats occur on the wetter areas. Lithosols are generally confined to exposed situations and ridges. The bog and fen areas retain water and act like a giant sponge. They also filter organic material, allowing clear water to slowly flow into the streams which feed the Snowy, Murray and Murrumbidgee Rivers.

Bogs and fens act like a sponge and allow water to steadily trickle into mountain streams.

Vegetation

A tall alpine herbfield, the type of landscape that was threatened by grazing early this century.

There are a variety of colourful plants in the alpine herbfields – snow daisy, billy buttons and montia.

Euphrasia in full bloom on feldmark, a unique biological community found on exposed, windswept ridges.

The alpine area supports a rich and distinctive vegetation and contains some species that are found nowhere else in Australia. Many alpine species have very slow growth rates because of the limited amount of energy available for photosynthesis. The short growing season and the contrasts between the cold winter-spring period, and the warmer summer-early autumn period, affects the flora. Many species remain dormant in winter and display rapid growth and flowering in the short summer period.

The location of the various alpine plant communities is related to the aspect of the slopes, the climate and the soils. The herbaceous communities –short and tall alpine herbfields and sod tussock grassland – together occupy the largest part of the alpine zone. The short alpine herbfield, characterized by dwarf mat-forming or creeping species such as plantain (**Plantago** species) and montia (**Neopaxia** species), is found below semi-permanent snow patches and permanently wet gravelly areas. Tall alpine herbfield communities are characterized by snow daisy (**Celmisia** species) and snow grass (**Poa** species) with herbs such as billy buttons (**Craspedia** species). In areas of shallow, stony, well-drained soils such as on the steep western slopes, heath shrubs such as plum pine (**Podocarpus** species) and alpine mint bush (**Prostanthera cuneata**) grow. Shrubs are often found around rocky outcrops because the exposed rocks absorb solar energy and provide locally warmer habitats for plant growth. On rocky and exposed windswept ridges and in snow-patch areas, biologically unique feldmark communities are found characterized by scattered dwarf prostrate plants **Epacris** and **Colobanthus**. In the permanently wet areas, carex fens and sphagnum bogs are dominant and play an important role in the hydrology of the mountains. Fens occur around the creek areas or wherever water ponds on relatively flat surfaces. The bogs, characterized by sphagnum (**Sphagnum cristatum**), are spring-fed by seepages down the hillsides or along the edges of the valleys.

Animals

Only a very few native species of animals, birds and insects survive in the harsh alpine climate. The pygmy possum is a special inhabitant of the high country which was thought to be extinct for many years. Others such as wombats, marsupial mice and larger possums wander up to the alpine region in summer. The high country contains an environment with a unique and delicately balanced ecology that is easily damaged or destroyed.

Despite its colours the Corroboree frog blends well with its environment. (Photo: Densey Clyne).

The Kosciusko grasshopper (Kosciuscola tristis) changes to a dark colour when the temperature drops below 15° C, to absorb more solar radiation and to a blue green colour when the temperature rises above 25° C, in order to reflect some of the heat away from its body. (Photos: Densey Clyne).

Erosion Processes

Soil is lifted by needle ice and during the thaw dropped loosely back to the ground.

In winter the soil is largely protected by the snow cover, but in other seasons wind, frost, ice and running water acting with freeze-thaw cycles provide perfect conditions for rock weathering and soil erosion. The freeze-thaw cycles have the greatest impact in spring and autumn. During the freeze, ice needles form in the soil and lift the particles. In the thaw, particles and rock material are dropped loosely back onto the surface where they are easily blown or washed away.

Vegetation has an insulating effect and protects the soil from wind and water erosion. Once this protective cover is lost, the harsh alpine climate quickly begins to erode the soil, carrying sediment into streams and dams.

Droughts also affect the mountains. The soil dries out quickly at these altitudes, leaving the surfaces very prone to water and wind erosion.

EARLY HISTORY OF ALPS

The Aborigines

The Australian high country is relatively poor in game and the alpine flora lacks edible plants. Consequently the Aborigines had no reason to permanently occupy the Kosciusko region or to burn its vegetation. Instead, in mid-summer each year, aboriginal tribes gathered in the high country to collect and feast on Bogong moths which had migrated to the mountains. The Aborigines who visited the high country for thousands of years had little impact on this sensitive environment.

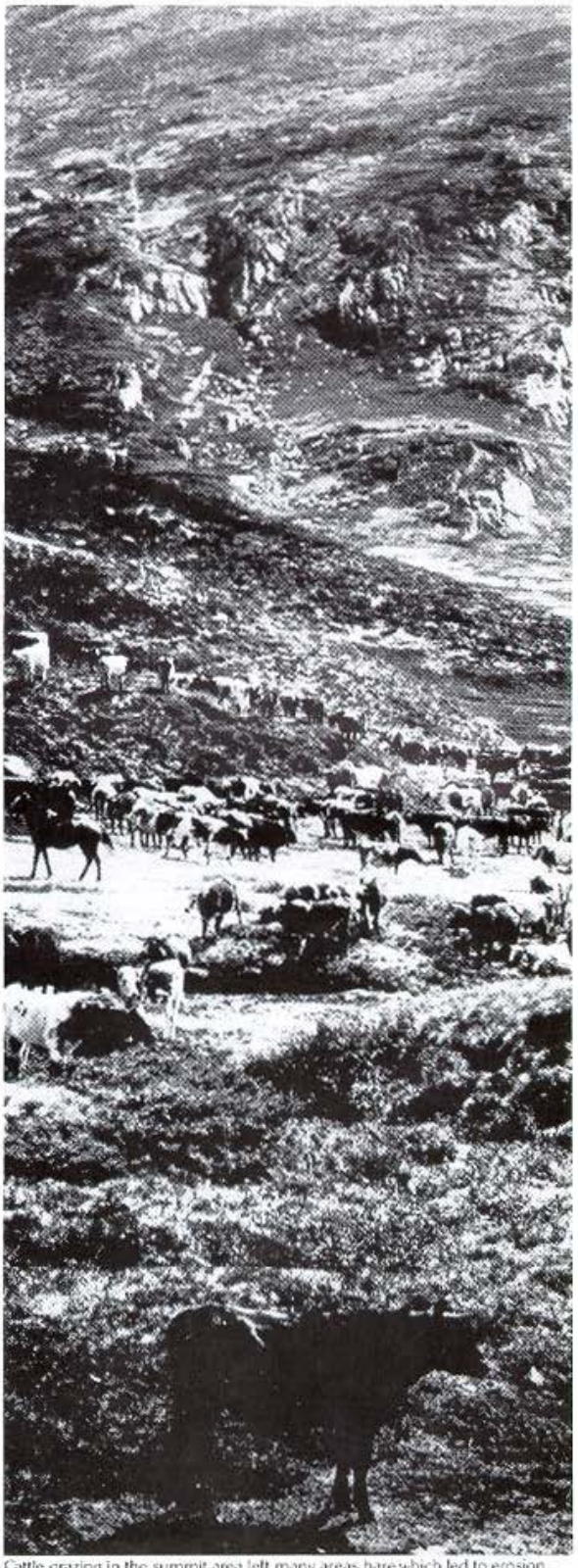
The Aborigines visited the alpine area to hunt the fat and juicy Bogong moths that cluster in rock crevices during summer. (Photo: Glen Carruthers, Mantis Wildlife Films).

Grazing and Burning

The high mountain pastures were first discovered by Currie and Evans in about 1829 and it is generally believed that summer grazing of sheep, and to a lesser extent cattle, began soon after. James Spencer, a well known squatter of Waste Point, Jindabyne, was the first to use the summit area for grazing. The early settlers travelled hundreds of miles from western New South Wales as well as from localities adjacent to the Snowy Mountains to graze their animals on the snow grass pastures in summer. Fire was used as a management tool to produce fresh green growth from the otherwise unpalatable snow grass. Burning also helped dry out bog and swamp areas to allow better access for bullock drays and pack horses.

After years of grazing and burning much of the grassland and herbfield communities had eroded and the feldmark communities were badly damaged. Once the insulating effect of vegetation was removed, needle ice attacked the soil, while frost and wind undermined the plant roots. Stock selectively removed the herbs between the snow grass tussocks and in doing so allowed topsoil to be removed. Water and wind erosion further stripped any remaining topsoil, leaving only stony subsoils or erosion pavements. The subsoils are acidic, infertile and low in organic matter and are difficult areas for plants to re-establish. Because of the short growing season (December-March) and the harsh climate, the vegetation had little time to recover before the onset of winter in April-May.

Heavy rain following burning, washed topsoil into the rivers and creeks, choking them with debris and increasing sedimentation in the catchments. Cattle and sheep were attracted to the bog areas and damaged them by trampling. They also created tracks along which water flowed, resulting in further drying out of the bogs. Additional grazing pressures were created when gold miners, who had settled in the sub-alpine areas around Kiandra in the 1860s, took their stock into the high country to compete for the available forage.



Cattle grazing in the summit area left many areas bare which led to erosion. (Photo: Courtesy of National Library, Snowy Mountains - Ferguson Collection).

Snow Leases and Grazing Control

In 1889 summer grazing was formalised by the New South Wales Department of Lands when the Snow Lease Tenure Act was passed. This controlled areas allocated to leaseholders but did not control livestock numbers. The area was heavily grazed during the severe 1890-1901 drought. In 1906 an area of about 260 square kilometres, from the summit to the Murray River, was set aside for the Snowy Mountains National Chase but no trustees were appointed to manage this reserve. At the same time tourism and recreational activities became significant land uses after the completion of the Kosciusko Hotel and the Jindabyne to Kosciusko Road.

By the 1920s public concern over the degradation of the high country increased. Both Sir William McKell and Mr. E.S. Clayton were concerned about the accelerating erosion in the State's alpine areas – Mr. Clayton had helped draft the Soil Conservation Act and in 1938 was made first the Director and later Commissioner of the New South Wales Soil Conservation Service. The 1938 Act constituted the Snowy River and its tributaries as an area of erosion hazard. However, the increasing damage to water catchments and the loss of soil prompted Mr. Clayton to point out to Sir William (then New South Wales Premier) the seriousness of the situation. Fortunately, Sir William had the same intense interest in the Snowy region and was determined to protect it. In 1943, after much pressure from scientific and conservation groups, he introduced snow leases that restricted stock numbers and burning. Graziers were only allowed to lease the high country for seven years and a definite grazing season was established. In 1944 Sir William McKell was largely responsible for the establishment of the Kosciusko State Park, an area of approximately 5,000 square kilometres.

With the establishment of the Park and further pressure from conservation groups, the CSIRO and some government groups, grazing in the summit area was progressively phased out. With the development of the Snowy Mountains hydroelectric scheme (1948-72), further snow leases were withdrawn. By 1958 grazing was prohibited in all areas above 1,370 metres and the Soil Conservation Service commenced revegetation and repair works. Some graziers, however, continued to graze their animals illegally.

In 1967 the National Parks and Wildlife Act was passed and two years later grazing in the Park was totally banned. Despite the cessation of grazing it will take decades for the land to return to its original, stable condition.

Pedestals of silver snow daisy and stony erosion pavements left after years of grazing and trampling by stock.

REPAIRING THE DAMAGE

In the mid 1950s the New South Wales Soil Conservation Service was given the job of repairing the damaged and eroded areas created by years of grazing. A long range program was developed to stabilise soils in the area and prevent siltation and pollution of the rivers and lakes utilised in the Snowy scheme. A protective cover of vegetation offered the only effective long-term control of soil erosion.

Surveys found that the worst erosion was on the Main Range, from Mt. Kosciusko to Mt. Twynam. There were over 5,560 hectares of minor to severe sheet erosion in the section of the Main Range between Dead Horse Gap on the Alpine Way and the Schlink's Pass Road. Minor sheet erosion occurred when water running over the surface removed soil and some vegetation, leaving small bare patches of ground between the individual tussocks of snow grass. These areas regenerated naturally when grazing was excluded. Moderate sheet erosion left larger areas of bare ground, where the intervening tussocks had died out. Severe sheet erosion represents the third stage, where areas suffering from moderate sheet erosion joined to form large areas of bare ground or erosion pavements. In some of these areas soils had been lost to a depth of 60 cm. Reduced vegetation cover and stock trampling led to increased runoff. Channels and gullies formed in depressions, along drainage and flow lines and close to stock routes. Areas affected by moderate and severe sheet erosion required carefully planned regeneration treatment.

Gullies formed in depressions or along drainage lines and were difficult and expensive to repair. This gullied track had to be filled and revegetated.

Repairing the damaged areas involved establishing a stable vegetation cover as quickly as possible to prevent frost heave and to create the surface stability so essential for native species to re-establish. In some instances more substantial structures to control water runoff were needed. In severely eroded areas, banks were built across the slope to reduce runoff. This was followed by reshaping of the site before the area was seeded and fertilised. After seeding and fertilising by hand, the treated area was covered with straw or hay mulch. This protected the soil from wind damage and frost heave and provided a better environment for germination. In the early years this mulch was covered with wire netting to hold it down, but because of handling difficulties and the leaching of zinc toxins from the wire, its use was discontinued. It was replaced by bitumen spraying, since in time, bitumen eventually decomposes.

Stone drains and contour banks were constructed by hand to control runoff – this was time consuming and back breaking work.

Gullies were repaired by building rock weirs across their beds and then transplanting sods of montia alongside and across the weirs, to trap soil. Larger gullies required more extensive stabilisation with rock gabion structures.

Throughout the program considerable investigation work was done, including the erection of a small weather station to record rainfall, wind speed, air and ground temperatures. These investigations were essential to the success of the whole program because they determined the effectiveness of new materials and techniques. The seed used in the revegetation was from introduced or

Stone weirs are built across creeks to reduce the velocity of water and trap sediment. Montia, a mat-forming creeping plant is transplanted by hand and slowly recolonises, once more bridging the creek.

exotic species because of the ready availability of the seed, the wide range of species tc choose from and the proven performance of these species in other alpine areas. There was insufficient information on the germination, establishment and performance of native species and it was doubtful that indigenous species could have provided the rapid cover necessary to effect rapid stabilisation. Species from the high altitude areas of New Zealand, such as chewings fescue, highland bent, clovers and perennial rye grass were found to be the most successful colonisers over a range of habitats. In small areas native and introduced species were transplanted by hand from stable areas of vegetation. Larger areas were seeded and fertiliser was applied in gradually decreasing quantities, over several years. As ground cover was re-established and fertiliser reduced, native plants such as montia recolonised newly vegetated areas. These native species are better suited to the environment in the long term and do not require maintenance or fertiliser.

One way to stabilise large and badly eroded gullies is to use rock filled baskets called gabions. These are placed at the head and along the sides of the gully to prevent mass movement of soil.

Living and working in the alpine area was extremely difficult. The repair and construction work commenced by the Soil Conservation Service was mainly done by hand. This required a large labour force. Transporting men and materials to the summit was difficult because of the steep terrain and lack of access tracks. Equipment had to be transported into the area rapidly and temporary accommodation established. Workers were required to work long hours – sometimes up to ten days without a break. Each year, the period during which work could be carried out was very short – often only from December to March.

In 1957 Soil Conservation workers were housed in tents but these were later replaced by a prefabricated hut after severe weather destroyed the "tent" city.

The first experimental stabilisation program began in the Carruthers Peak area in 1957 and a "tent" city was established to accommodate the workers. This was destroyed by a violent wind storm, setting the program back, and was replaced in 1961 with a prefabricated hut that allowed regular soil conservation work to continue each summer. Initially, labour for the revegetation project was provided by the Snowy Mountains Authority but this was soon replaced by Soil Conservation Service staff.



Getting men and materials into the mountains was difficult. As technology improved helicopters and four-wheel drives such as Haflingers replaced the horse.

As access was difficult, transport was very important. In the early years equipment and materials were transported by pack horse. As technology improved these were replaced by four-wheel drive vehicles and helicopters. Since 1977 the National Parks and Wildlife helicopter has been used for the transport of all workers and materials, allowing old access tracks to be revegetated.

More recently, the increased use of the alpine area for recreation has resulted in erosion along roads and walking tracks. Plants have been killed and soil exposed by summer walkers constantly using the same track. This leads to the development of a narrow channel which becomes difficult to walk on, so new tracks are formed on either side of it. In recent times hard wearing gravel or paving surface, mesh and boards have been used to reduce walking traffic damage. Cross drains have also been installed to carry runoff and footbridges have been built over wet areas. All these walking tracks and structures now require annual maintenance and the co-operation of park users to ensure that sensitive areas are protected.




The old track between Carruthers Peak and Mt. Twynam was so deeply eroded it had to be filled with hay bales and covered with top soil before seeding, fertilising and bitumen spraying could begin. The final photo taken in March, 1985, shows the revegetated track with greater concentrations of snow grass alongside the fertilised areas.

Erosion in the alpine area is now caused by people. Multiple paths are created by walkers

Tracks such as the Charlotte's Pass walkway require annual maintenance by the National Parks and Wildlife Service. The weight of snow on the raised walkways causes them to bend or break under pressure.

A QUIET ACHIEVEMENT

Soil Conservation Service personnel working on the badly eroded slopes of Carruthers Peak in 1957. The same area 25 years later illustrates the successful recolonisation with native species such as snow daisy and snow grass.

Over the years the absence of grazing, combined with the Soil Conservation Service's program, has allowed many areas to approach their natural state. Natives such as montia (**Neopaxia** species), mountain celery (**Aciphylla** species) and ribbony grass (**Chionochloa** species) are starting to reappear in treated and or ungrazed areas. Runoff has decreased and creeks are no longer clogged and clouded with sediment. It is a tremendous achievement, considering the difficulties of access, the expense of reclaiming damaged areas, the

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labour intensive work and the extreme climate.

Although burning and grazing no longer threaten the Kosciusko alpine area, new problems are emerging associated with the increasing number of visitors to the region. In alpine areas erosion along walking trails and paths is a major problem. In sub-alpine areas there is an increasing demand for parking, accommodation and ski facilities. Erosion is now a result of human rather than grazing activities. The Soil Conservation Service, in association with the National Parks and Wildlife Service, continues to monitor and maintain soil conservation works in the summit area. In sub-alpine areas it is actively involved in revegetating road batters and construction sites.

The Blue Lake walking trail.

The Kosciusko-Snowy Mountains area is a unique and valuable resource that still requires careful management. It is an environment that contains conflicting land uses which must be accommodated while still maintaining the natural vegetation cover and good water quality. The Soil Conservation Service provides soil conservation advice and assistance to all people and organizations who seek to use or develop part of this fragile area of New South Wales.

The alpine regions are a unique and valuable resource that should be managed for the benefit of current and future generations of Australians (Photo: C. Totterdell).

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