https://doi.org/10.26749/rstpp.106.1.1

"CHARACTERISTICS AND USE OF AUSTRALIAN HIGH COUNTRY"

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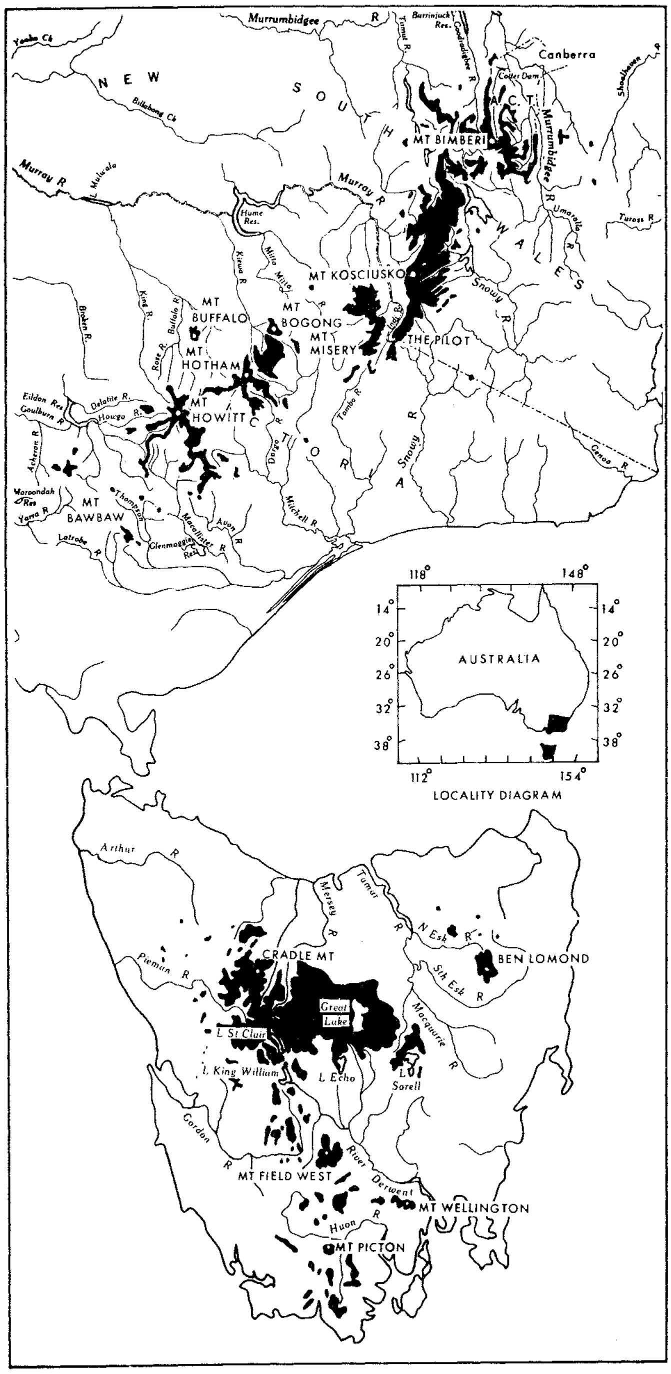
In Tasmania, with its high proportion of rugged terrain, it is easy to forget that high mountain environments are poorly represented in Australia. If we define such environments generally as the sub-alpine and alpine areas (i.e. areas above climatic treeline and extending for 1000 to 1500 ft below it) we account for some 2500 sq m. (6480 sq km) of Tasmania and about 2000 sq m. (5180 sq km) of mainland Australia (Fig. 1). The Central Plateau, and the Snowy Mountains in N.S.W., are the two most extensive areas. The Tasmanian high country represents about 10% of the State but the mainland areas in New South Wales (including the A.C.T.) and Victoria comprise only about 0.07% of the mainland. The Tasmanian and mainland areas together comprise approximately 0.15% of Australia. Clearly, Tasmania has a custodian responsibility for Australia as a whole, as well as a large personal stake in its high country.

ENVIRONMENT

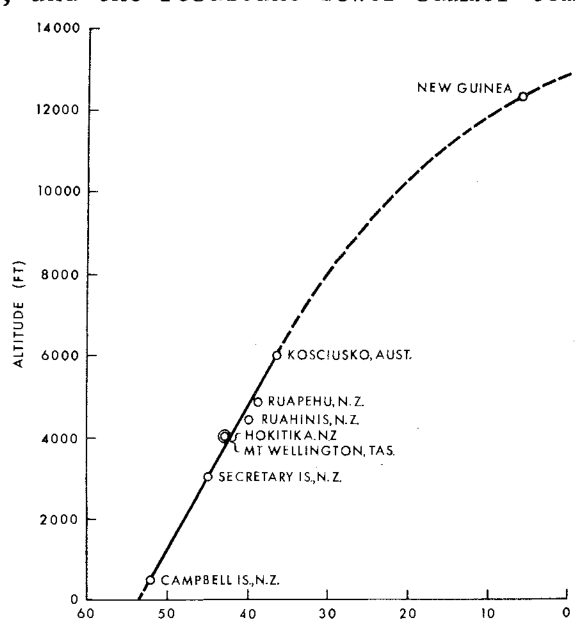
There is usually little difficulty in defining the lower limits of high mountain country in Australia in those situations where it rises abruptly above the adjacent land. But we should look for more critical and if possible general criteria. The most universal criterion appears to be summer temperature which is closely related to treelines throughout the world both in alpine and in arctic and subantarctic regions (e.g. Daubenmire 1954). The climatic limits of tree growth both in altitude and latitude are found to occur where the mean temperature of the warmest month does not rise above about 50°F (10°C) and this is the case both in Tasmania and on the mainland (Costin 1967a). The areas above and down to about 1000 to 1500 ft (300-450 m) below climatic treeline comprise, respectively, the so-called alpine and subalpine zones. There are other criteria associated with these low summer temperatures including frequent frosts, surficial solifluction, low winter temperatures, persistent snow cover (of at least 1 month)



1. Distribution of high mountains in Australia (from Costin 1967b).

and restricted biological production, which also contribute to the identity of high country environments.

The areas mapped in Fig. 1 according to the above criteria are situated above about 4500 to 5000 ft (1370-1525 m) on the mainland and 3000 ft (915 m) in Tasmania. The apparently unusually low subalpine limit in Tasmania is a result of the cool oceanic summers. The lower altitudinal limits may be further reduced as on parts of the Central Plateau and the cold air plains of the mainland by unfavourable site factors including cold air drainage, wet soils, exposure to strong winds or periodic fire. Figure 2 relates the Australian high mountain areas to others in the Australasian region, in terms of latitude and altitude. It will be noted that the altitudinal level increases by about 360 ft (110 m) for each degree decrease in latitude. This is similar to the position in the Northern Hemisphere (Daubenmire 1954) except that at equivalent latitudes the high mountain environments in the north are generally situated at higher altitudes than in the south. For example, the treeline at latitude 43 in the North American Rockies is at about 10,000 ft (3000 m); compared with about 4000 ft (1200 m) on Mt. Wellington. As noted above these differences are related to the more oceanic climate of the Australasian mountains, and the resultant lower summer temperatures.



2. Altitude of Australasian treelines in relation to latitude (from Costin 1967a).

Some of the Australian high mountains are steep but most are in the form of plateaux often defined by relatively abrupt scarps (Costin 1957, Davies 1965). Because of its situation in the belt of westerly wind regime and associated sub-antarctic low pressure influences this plateau terrain intercepts heavy precipitations - from about 30 inches (760 mm) in some of the relatively dry subalpine areas up to more than 100 inches (2540 mm) in leeward alpine sites. Stream flow is consequently high and reliable compared with most other parts of Australia. Tasmania contributes more than 38,000,000 acre ft ($4.7 \times 10^{10} m^3$) of Australia's average annual run off of 280,000,000 acre ft ($34.5 \times 10^{10} m^3$), with a higher water yield per unit area than any other drainage division (Australian Water Resources Council 1963). The River Murray system of some 440,000 sq m. (1,140,000 sq km) receives approximately ¼ of its annual average flow (12,000,000 acre ft, $1.5 \times 10^{10} m^3$) from about $^1/100$ of the total catchment area - the high mountain zone.

The above characteristics were also important during the cold periods of the Pleistocene in producing extensive glacial and/or periglacial conditions, the effects of which contributed further to the uniqueness of the Tasmanian and mainland high mountain areas compared with the rest of Australia. In Tasmania, glacial activity affected hundreds of square miles (Davies 1965) producing thousands of glacial lakes, hundreds of cirques and extensive moraines and other glacial features. On the mainland, on the other hand, well developed glacial features are few and the glaciated areas may not have been much more than about 20 sq. m (50 sq km) (Galloway 1962) although the extent of the mainland glaciations is still a matter of debate (Peterson 1971). Associated periglacial activity was widespread in both areas producing extensive slope deposits especially in areas of mechanically fissile rocks such as the dolerites of the Central Plateau (Banks 1965) and the basalts of the Victorian Bogong High Plains (Carr and Costin 1956) and the Toolong Range in the Snowy Mountains (Caine and Jennings 1968). The available evidence indicates that at least on the mainland, the last main period of periglacial and glacial climate extended from about 32,000 to 15,000 years ago and locally perhaps until about 9000 years ago before conditions became appreciably warmer. A less severe cold interval was experienced about 3000-1500 years ago (Costin 1973).

The glacial and periglacial history of the high mountain areas has had important implications for soil development. In the more extensive glaciated Tasmanian areas the post-glacial soils tend to be thin (Nicolls and Dimmock 1965) - either lithosolic where well drained or peaty where wet. The periglaciated areas, with their extensive slope deposits, have deeper profiles including both screes and block streams and alpine humus soils. Thus the Tasmanian areas generally have relatively stonier and peatier soils than the Australian Alps where the deeper organomineral alpine humus soils are more common (Costin 1955).

The present environment and climatic history of the high mountain areas have also produced a characteristic biota. The so-called southern elements - with origins in New Zealand, South America, Antarctica and South Africa - are strongly represented among the more widespread Australian, tropical and cosmopolitan types more typical of the Australian biota generally. This can be seen from Table 1

TABLE 1. Geographical Elements of the Floras at Different Levels in the Monaro Region, Snowy Mountains Area, N.S.W.

Level	Geographical Element							
	Southern		Australian		Tropical		Cosmopolitan	
	No. spp	%	No. spp	%	No. spp	%	No. spp	%
Tableland (2000-3000 ft)	22	5	193	50	34	9	136	36
Montane (3000-5000 ft)	29	6	242	53	33	7	152	33
Subalpine (5000-6000 ft)	37	14	93	36	6	2	125	48
Alpine (>6000 ft)	42	22	58	31	2	1	88	46

for a sample flora from the Monaro region of N.S.W. which shows the progressive increase in the southern elements with increasing altitude. Another feature of the biota is its high degree of endemism. In Tasmania some 50% of the high mountain flora is endemic, including several shrubby conifers (*Pherosphera, Microcachrys, Diselma*) and cushion plants (*Abrotanella, Donatia*) of great scientific interest. Among the fauna the notable elements are the invertebrates, especially the insects and crustaceans, many of which similarly are endemic and show southern affinities. By contrast, the mammal fauna contains few distinctive high mountain species (e.g. Guiler 1965), although at Kosciusko there have been some notable finds (of *Mastacomys fuscus* and *Burramys parvus*) in recent years (e.g. Gall 1972).

The main vegetation features of the Tasmanian and mainland high mountain areas have been illustrated by Jackson (1965) and Costin (1957). These features are summarized in Table 2. It will be seen that subalpine woodlands are the climatic climax vegetation in the subalpine belt (approximately 3000 to 4000 ft - 915 to 1200 m - in Tasmania, and 4500/5000 - 1370/1525 m - to 6000 ft - 1830 m - on the mainland), the characteristic dominants being *Eucalyptus coccifera* and *E. gunnii* in Tasmania and *E. niphophila* on the mainland. The Tasmanian areas also include rain forest thickets of the endemic *Nothofagus gunnii* and *Athrotaxis* species. On the mainland the woodland understory typically has a strong herbaceous component of various species of snow grass (*Poa* species) and a wide range of forbs; in the Tasmanian woodlands, with their generally stonier soils, shrub understoreys are better developed.

In Tasmania the trees give way at about 4000 ft - 915 m - to extensive alpine heaths, and on the mainland at about 6000 ft - 1830 m - to alpine herbfields with heaths in rockier situations. Under conditions of cold air drainage into semi-enclosed valleys the woodlands are commonly replaced by grassland communities as on parts of the Central Plateau and the so-called high plains of the mainland. Wet areas both in the subalpine and alpine belts support a variety of bog, fen and cushion heath (in Tasmania) communities, usually with marginal wet heaths containing mainly epacridaceous and myrtaceous species. Snow patch and feldmark communities (on the mainland) have more localized occurrences under conditions of prolonged snow cover and exposure to very strong winds. It will be noted that although the high mountain communities of the mainland and Tasmanian areas have much in common, shrub-dominated vegetation including the distinctive cushion heaths and conifers, is more important in Tasmania and different species dominate the subalpine tree communities.

PAST AND PRESENT LAND USE

Aboriginals

As Hancock (1972) points out for the Snowy Mountains the first users of the high country were the aboriginals, who made annual visits to feast on the noctuid Bogong moths, *Agrotis infusa*. Although this seasonal aspect of aboriginal use is well documented there is little evidence of permanent effects at high elevations or of permanent occupation in the vicinity. For example, many apparently suitable caves as low as Yarrangobilly (approximately 3500 ft - 1070 m) show no evidence of occupation, and formerly inhabited caves at somewhat lower levels contain artefacts evidently of recent origin (Flood, A.N.U. personal communication). No old C-14 dated sites of habitation have yet been discovered (Costin 1971a) to match the much older ones inland and on the N.S.W. South Coast (Lampert 1971). This probably reflects the cold and inhospitable climate which seems to have prevailed in the mountains and adjacent tablelands from about 30,000 until at least 15,000 years ago (Costin 1972).

Similarly, from the known distribution of aboriginal archaeological remains in Tasmania (Bryden and Ellis 1965) many mountain areas appear to have been little used and probably little affected by the aboriginals, although there is evidence (Jones 1971) that they were present on the Central Plateau. Here marsupials and water birds appear to have been common - possibly because of the relatively low elevation and well watered character of the Plateau - and supported a considerable aboriginal population during the summer months (Ellis, this symposium).

Grazing

The use of the high country as native pasture for domestic livestock dates from the 1830's and 40's (Hancock 1972, Scott 1955). The most extensive areas to have been grazed are the Central Plateau and the Snowy Mountains. Whereas the Tasmanian regions have been used mainly by graziers from adjacent lowlands, the mainland areas have at times been used by graziers in the semi-arid and arid zones as well as by those nearby. In the 1950's, before extensive closure of some areas to livestock, summer grazing in the high mountains involved some 500,000 dry sheep equivalent in N.S.W., 250,000 in Victoria and 160,000 in Tasmania

TABLE 2. Major Plant Communities of Australian High Mountain areas.

Structural unit	Main dominants	Distribution
Sod tussock grassland	*Poa caespitosa* (sens. lat.) *Danthonia nudiflora* *Calorophus lateriflorus* *Themeda australis*	Widespread along valleys and in basins of cold air drainage, especially in sub-alpine areas.
Tall alpine herbfield	*Celmisia longifolia* *Poa caespitosa* (sens. lat.) *Helipterum incanum* var. *alpinum* *Danthonia frigida*	The main alpine community above tree line on mainland; restricted in Tasmania.
Short alpine herbfield	*Plantago muelleri* *Montia australasica* *Caltha introloba* *Brachycome stolonifera* *Ranunculus inundatus*	Local occurrence beneath alpine snow patches with persistent (>8 months) snow cover, especially on mainland.
Fen	*Carex gaudichaudiana* *Danthonia nudiflora* *Festuca muelleri* *Eleocharis acuta* *Poa caespitosa* (sens. lat.)	Widespread locally in wet, acid, almost level alpine and sub-alpine situations, influenced by mineral soil.
Bog	*Carex gaudichaudiana* *Sphagnum cristatum* *Epacris paludosa* '*Epacris serpyllifolia*' auctt. *Callistemon sieberi* *Richea continentis* *Restio australis* *Carpha nivicola* *Astelia* spp.	Widespread locally in wet, acid valley situations and around hillside springs, both in alpine and sub-alpine areas; relatively little influence of mineral soil.
Feldmark	*Coprosma pumila* } *Colobanthus* sp. } *Epacris petrophila* } *Veronica densifolia* } *Ewartia nubigena* }	Local alpine occurrences above persistent snow patches and in very wind-exposed situations.

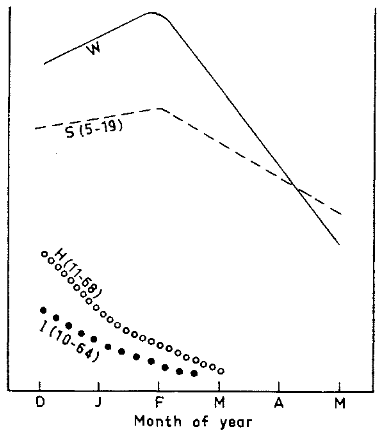
	Kelleria tasmanica *Helipterum incanum* var. *alpinum*	
Cushion heath	*Abrotanella forsteroides* *Donatia novaezelandiae* *Phyllachne colensoi* *Pterygopappus lawrencei* *Astelia* spp. *Oreobolus* spp.	Wet alpine situations in Tasmania.
Marginal wet heath	*'Epacris serpyllifolia'* auctt. *Epacris* spp. *Kunzea muelleri*	Locally common in damp situations marginal to bog.
Heath	*Oxylobium ellipticum* *Podocarpus lawrencei* *Lissanthe montana* *Phebalium ovatifolium* *Orites lancifolia* *Prostanthera cuneata* *Acacia alpina* *'Hovea longifolia'* auctt. *Drimys vickeriana* *Leucopogon hookeri* *Bossiacea foliosa* *Kunzea muelleri* *Kunzea peduncularis* *Baeckea gunniana* *Callistemon sieberi* *Phorosphaera hookeriana* } Tasmania *Microcachrys tetragona* } *Diselma archeri* }	Widespread in rocky situations, especially in Tasmania.
Sub-alpine woodland	*Eucalyptus niphophila* *E. stellulata* *E. pauciflora* form. *pendula*	Widespread sub-alpine community on mainland.
Sub-alpine woodland*	*Eucalyptus coccifera* *E. gunnii*	Widespread sub-alpine community in Tasmania.

* Also includes patches of rainforest of *Nothofagus gunnii* and *Athrotaxis* spp.

(Costin 1970). At that time, the value of high country grazing in N.S.W. and Victoria was of the order of $1 per acre ($2.50 per hectare) per annum, and represented roughly 0.1% of the value of sheep and cattle production in these two States (Australian Academy of Science 1957).

Choice of livestock depends to a considerable extent on the dingo hazard. Thus some of the Victorian areas which are scattered as small units surrounded by steep heavily timbered country are given over to cattle; in contrast to the larger, more continuous and open areas in the Snowy Mountains and Central Plateau with relatively less surrounding timbered country which are or have been used mainly for merino sheep. In mainland Australia, virtually all of the high mountains are Crown Land and were (and in parts of Victoria still are) made available as grazing leases; in Tasmania there are some areas of freehold as well as leasehold. The grazing season extends from about December to May. It is essentially of the rangelands type where natural features - shelter, water, preferred grazing types - are more important in livestock distribution than fences. The main form of pasture management has been periodic burning of the vegetation to increase the palatability of the herbaceous species and to reduce the amount of scrub.

Livestock carrying capacity and the high mountain pastures and soils have generally deteriorated under rangelands-type grazing and burning, despite the fact that there is always an apparent abundance of residual ungrazed pasture. The main reason for the decline in livestock carrying capacity is that in sparse grazing systems grazing is usually very selective concentrating on the more palatable species in the pasture and avoiding the less palatable ones. Under Australian conditions the relatively palatable and nutritious species are mainly the forbs (herbs other than grasses) which grow in between the less palatable grass tussocks and shrubs. Many of these forbs are also the natural colonizers of bare areas. Thus livestock gain weight as long as there is an adequate supply of forbs, mainly the inter-tussock species. Then the grass inflorescences and seed heads which are also fairly palatable and nutritious are eaten; finally the mature leaves of snow grasses themselves are grazed. At this stage a rapid loss in body weight begins. Since there is usually still a sufficient quantity of dry matter available the performance of livestock is more related to the quality



3. Generalised changes during grazing season at Kosciusko of sheep bodyweight (W) in relation to quantities of the main components of the community; snowgrass leaves (S), minor herbs (H), and snowgrass inflorescences (I). Average values for per cent crude protein and per cent digestibility respectively of S, H, and I are shown in brackets (e.g. snowgrass leaves have average values of 5% for crude protein and 19% for digestibility) (from Costin 1970).

than the quantity of available feed. This can be seen from Figure 3 which shows the changes in sheep body weight during the grazing season in relation to the availability and palatability of the various pasture components: mature snow grass leaves, snow grass inflorescences and minor herbs. The palatability of the mature snow grass plants can be improved by periodic burning (Costin 1970).

Under this type of grazing system the apparently sparse overall stocking rates of less than a ¼ dry sheep equivalents per acre (½ per hectare) represent effective stocking rates of up to 10 sheep per acre (25 per hectare) in terms of the areas actually grazed. Such heavily grazed areas become bare enough to encourage frost heaving of the now inadequately protected soils with the development of soil erosion. Some of the subalpine eucalypts in the young regenerating condition after fire are also palatable to sheep and can be killed by selective grazing. Thus more than a century of selective grazing and burning has greatly altered the structure and composition of the vegetation, most of which we tend to regard as still largely natural.

Because of the increasing concern by catchment authorities for soil erosion and loss of water catchment potential of the high mountain areas, grazing has been eliminated in N.S.W. and reduced in Victoria. The main grazing activity is now in the Central Plateau of Tasmania, although as Scott (1955) has pointed out this has also been declining due to the above mentioned run-down in the native pastures and the associated problem of rabbit infestation (cf. Parker and Bults 1967). Select areas of high country would respond to pasture improvement although this would be more expensive than at lower levels.

Mining

Mining, with grazing, provided much of the colony's earliest source of wealth, and parts of the high mountain country also contributed. Gold was exploited in many areas, the main one being the Kiandra goldfields in the Snowy Mountains. In their hey day in 1860 the goldfields supported up to 15,000 people. However, mining was already dwindling by 1863 and ceased about the end of the century. Many of the scars made in the landscape by mining are still incompletely vegetated, a reminder of the difficulties of the high mountain environment for plant growth. The main form of mining today is that associated with quarrying and with sand and gravel stripping for roads and other engineering structures.

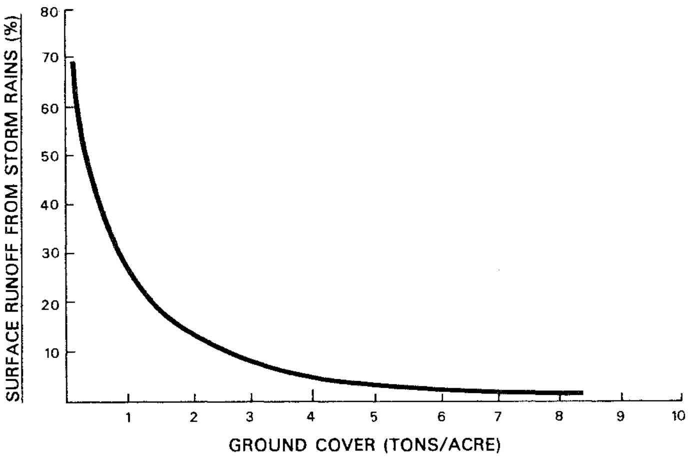
Water Harvesting

The water yield and elevated terrain of the mountain areas and their proximity to centres of urban and agricultural development give them high value as water supply catchments, for hydro-electric, agricultural, industrial and domestic uses. The first power supply schemes, in Tasmania and the Victorian Bogong High Plains, began as private undertakings but they were soon taken over and developed by the States (Garvie 1965). In N.S.W. the Commonwealth government provided the final stimulus for the construction of the Snowy Mountains Hydro-electric scheme.

Hydro-electric power in Victoria and N.S.W. has been regarded mainly as a peak load facility to supplement base load stations, but in Tasmania which is virtually lacking in suitable sources of thermal power hydro-electric development has also been used mainly for base load supply. Tasmania's industrial development has been far more dependent of its hydro-electric resources than has similar development on the mainland and, in contrast with the mainland areas, further major development of hydro-electric power can be expected. Considering water as a crop, its average annual value in the high mountain catchments has been estimated at between $40 and $90 per acre ($100-$220 per hectare) in terms of the cost of power and irrigation water to the user, reaching several hundred dollars per acre in the wettest and most elevated areas. Few other crops approach water in value (Australian Academy of Science 1957).

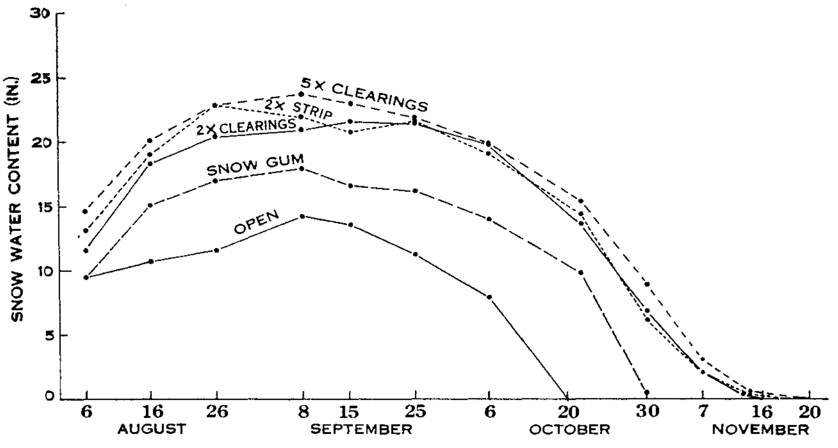
The realization of these high potential returns has involved large expenditures in water storage and diversion structures, power stations and transmission lines and the associated development of roads, construction camps and operational centres. The need to ensure sustained operation of these facilities has increasingly focused attention on problems of catchment protection, improvement and management. There are two main groups of problems: the protection of the catchment from soil erosion and of the storages and other structures from sedimentation, and the maximization of controlled water yield (Costin 1967b). The first problem requires that sufficient surface vegetation be retained on the catchment to promote infiltration of moisture and therefore minimize soil loss. For the organomineral soils of the mainland areas about 4 tons per acre (10,000 kg/per hectare) (oven dry weight basis) of herbaceous vegetation (or 8 to 10 tons of shrubs or sclerophyll litter - 20,000 to 25,000 kg per hectare) provides adequate protection against storm rains (Figure 4 On permeable stony soils less cover may be required. Similar ground cover relationships can be developed for the protection of the surface soil against frost - and wind - erosion. The second problem of high water yield (with the constraints that surface run-off and soil loss should be small) requires that the vegetation should have minimal water use and maximum effect in accumulating precipitation and, in the case of snow, of delaying snow melt. In the moist high mountain environment, plant communities do not appear to differ much with respect to water use but they differ widely with respect to their collection and detention of precipitation. Trees or tall shrubs with a large surface area exposed to the prevailing moisture-laden winds are most effective (Figure 5).

To a large extent the undisturbed native vegetation provides the necessary amount of ground cover to minimize



4. Typical relation between ground cover and surface run-off, Kosciusko. The cover x soil loss relationship is similar. There is a rapid reduction in surface runoff and soil loss as the amount of herbaceous cover and litter increases to about 4 tons per acre (10,000 kg per hectare) beyond which there is relatively little change.

surface run-off and soil loss and the native tree and shrub cover is effective in catching wind blown moisture and delaying snowmelt. Thus catchment protection authorities, (at least on the mainland) have endeavoured to adjust land use to encourage the maintenance and recovery of the desirable conditions of ground and tree cover. In come cases where there is advanced catchment deterioration soil conservation and revegetation work are also being carried out. Further improvement in water yield could be anticipated by afforestation or construction of wind fences in some of the naturally treeless mountain areas especially along wind-exposed watersheds separating higher catchments upwind from lower catchments on the leeward side. Because of their greater height-growth, some of the North American subalpine conifers (e.g. *Picea engelmanni*, *Abies lasiocarpa* and *Pinus contorta*) would probably be more effective than local species, and could also have a timber potential. In this and other respects (Costin 1967b) intensive management for water yield would lead to vegetation conditions in places very different from the natural ones. Of course the development of water resources has already caused considerable local disturbance of the natural conditions through the impoundment and diversion



5. Depth of snow, measured in inches of water content, in relation to tree cover, Kosciusko. The amount and duration of snow cover are greater in association with snow gum vegetation than in the open, and still greater in small clearings in the trees. The roughness of the tree canopy, especially where there are small clearings, results in turbulence and downdrafts which favour the fall-out of wind-blown snow. Provided the clearings are not too large, the extra snow is not blown out again and is protected from rapid melting by shading from the trees. (x refers to the height of the snow gums surrounding the strip or clearing)(from Costin 1967b).

of water and the construction of roads and other works; these activities have also facilitated the spread of many alien plant and animal species (Costin 1971b).

Recreation and Tourism

The generally dry and flat condition of most of Australia has had the effect of concentrating recreation and tourist use on the restricted areas of high mountain environments which do occur; these areas, all in the south east are, furthermore, close to the main centres of population. At first the recreational and tourist uses were unsophisticated with few requirements other than the natural character of the environment itself and minimal facilities in terms of huts, roads, tracks and ski slopes. Whilst this type of use is increasing, in places with an untidy proliferation of private huts, tourism has now become a multi-million dollar business, with the establishment of luxury townships for year-round use, as at Thredbo in the Snowy Mountains.

An early, now taken-for-granted, effect of early recreational interest in the mountain areas was the successful introduction of brown and rainbow trout. The acclimatization was centred in Tasmania from which it was extended to the mainland areas. Only a few of the highest mountain streams and tarns are still trout-free and preserve the original aquatic fauna.

Nature Conservation

The scientific values of the high mountain areas, especially the glaciated landscape and the biota, have attracted increasing attention which dates well back into the last century (e.g. Hooker 1860). To a considerable extent use of an area for natural recreation and for water harvesting can be compatible with scientific nature conservation, and interest in all these uses has contributed to the establishment of a number of national parks and nature reserves. Tasmania's six major high mountain reserves comprise roughly one-fifth of its high country (c.f. Mosley 1968). In N.S.W., virtually all such areas (except the small Barrington Tops and the peaks of the A.C.T.) are in the Kosciusko National Park. Victoria with the relatively small Mt. Buffalo National Park has reserved less than 5%. Considering Australia as a whole, the high mountain ecosystems appear to be more adequately reserved than any other (Newsome 1972). However, the existence of commercial tourism and hydro-electric development in some of the reserves substantially reduces their size and value for some aspects of scientific nature conservation and for wilderness-based recreation.

FUTURE LAND USE AND MANAGEMENT

Thus several kinds of land use have made, and increasingly are making, different demands on very restricted environments - some 2500 sq m. (6480 sq km) in Tasmania and 2000 sq m. (5180 sq km) on the mainland. For freehold land, private ownership and the market system largely determine the type of land use, the result often being a hotch-potch of development and exploitation which may be difficult to reconcile with the public interest. For largely publicly owned land, on the other hand, there is at least the opportunity for rational land use planning, zoning and management in the public interest. Although the high mountain areas in Tasmania are in places alienated the Australian high mountains as a whole are predominantly State-owned. Thus there should be no insurmountable obstacles to achieving generally sound land use.

Increasingly, sophisticated computer-based methods of land evaluation, such as those used in Canada (Lacate 1972) are becoming available and fashionable. But the developers of these modern methods are among the first to point out the suitability of simpler approaches for the resolution of many land use problems. Whatever the method used, sound survey information is needed to identify the features of the area concerned. These features - geographical, physical and biological - enable a given area to be evaluated in terms of its suitability for various uses. The evaluation also takes into account the availability and importance of other areas for the uses in question. The area can then be rated according to its importance for various uses. Where, as is mostly the case, the same area is useful for several purposes, the compatibility of the less important uses with the major ones should be assessed; this leads to decisions as to the extent to which such use of the area is possible without detracting from the major use or uses. Where there are two or more major uses competing for the same kind of area and these uses are incompatible, parts of the area should, if possible, be allocated primarily for one of the main uses and part for the other; in other words multiple use is achieved through zoning. The crunch comes when an area is really the only one of its kind in terms of more than one conflicting major use; then a decision has to be made in favour of one use or the other. Such a conflict at Kosciusko between hydro-electric works and national parks values (Australian Academy of Science 1961) was finally resolved in favour of the latter values; the Lake Pedder issue in Tasmania appears to have been resolved in favour of hydro-electric development.

The results of this simple approach for evaluating land use potential of the Australian high mountains can be broadly summarized in Table 3. This evaluation has been evolving during the present century, although not without conflicts of interest. At first the private interests of grazing and mining were accepted without question. The important public interest uses of recreation and water harvesting then developed, resulting in the establishment in Tasmania and N.S.W. of major national parks, and the adoption of catchment protection

TABLE 3. Evaluation of Australian High Mountains for Various Land Uses.

Land Use	Importance of High Mountains for this Use	Availability of other areas for this Use
Forestry	-	+++
Grazing	+	+++
Mining	+	+++
Commercial Tourism	++	+++
"Natural" Recreation	+++	++
Water Harvesting	+++	+
Nature Conservation	+++	-

measures (especially control of grazing and fires) in N.S.W. and Victoria. Up to this stage (the 1950's), the land use conflicts, where they existed, were mainly between private and the so-called public interest. But as water harvesting developed further and the importance of the mountain areas for wilderness type recreation and as nature conservation reserves was better appreciated, the conflicts have increasingly involved *different* public interests. As yet, there has been no commercial forestry. Where stalemates have developed, their resolution has been a matter for the State government concerned.

In the final analysis, controversial land use decisions will fall to the government of the day. This is as it should be, provided there are adequate safeguards against hasty decisions including provision for informed public debate. But so far the decision making process of governments on environmental matters has been determined largely by the advice received from particular groups in the form of mainly single purpose government agencies, the influence of which is generally proportional to their size. A more neutral agency on environmental issues is needed at State and Commonwealth levels to evaluate all competing issues and to advise the government accordingly.

The problem of accommodating at least the four most important uses for water harvesting, nature conservation, natural recreation and commercial tourism would be easier to solve if a fresh start could be made by zoning all of the high country in terms of the most important and compatible subsidiary uses in various areas. But the situation has already developed in which several major uses have become established in the same area. The question now confronting land use planning in the Australian high country, including some national parks, is not *whether* there should be multiple use but *how* to accomplish this without a progressive deterioration of important values. A large part of the solution is straight forward in theory, if more difficult in the implementation. It includes two inter-dependent steps: preparing a zoning plan for each major park or other area, and developing an appropriate management plan for each of the zones.

In the largest and most complex high mountain area, the Kosciusko National Park, a zoning plan is now being finalized after several years of preparation and is likely soon to be approved. The plan provides for five main categories of use (Table 4), for which the appropriate and inappropriate other uses are also spelt out. Such zoning plans are important in resolving land use conflicts on the basis of carefully predetermined general policy rather than on an *ad hoc* basis. In the Kosciusko National Park commercial tourist development will be restricted to the areas zoned as such and potential developers know they will have to cut their coat accordingly. Similarly, problems of where horse-riding and mechanical over-snow transport are, and are not, appropriate can be resolved on general grounds rather than in terms of each individual case. Indications are that the public generally and individually welcome and respect such zoning provided it has been well thought out and freely discussed, whereas there are always people prepared to take advantage, with a let's-get-in-first attitude, of an unresolved situation.

The final requirement for successful land use

TABLE 4. Land Use Zoning Categories in the Kosciusko National Park.

Wilderness areas
Outstanding natural areas (including special scientific areas)
Natural areas
Development areas (including hydro-electric and tourist sites)
Historic sites

zoning is management appropriate to each particular zone. Such management usually has both negative and active aspects. For instance, management of the vegetation for water harvesting at Kosciusko, for which a combination of dense ground cover and trees is required, involves control of influences such as grazing and fires which reduce ground cover and inhibit plant regeneration; together with active regeneration works in those localities where the vegetation is not maintaining itself or is failing to make a sufficiently rapid recovery. Much active management is being found to depend on survey and mapping at more detailed levels than those suitable for the initial zoning plan (e.g. 1: 25,000 vs 1: 250,000). Whilst existing maps and survey information are generally adequate for zoning purposes, they are usually not detailed enough for management needs.

As at Kosciusko, zoning and management plans are required for the Central Plateau, and for other parts of the Tasmanian and Victorian high country.

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