

Cold-air 'lakes' in the Snowy

Up in the Snowy, open grasslands mixed in with the eucalypt woodlands give a varied and pleasant landscape. These grasslands are a common feature of the sub-alpine high country of New South Wales and Victoria.

Why trees won't grow on them has intrigued ecologists for many years. Historical records show that they pre-date European settlement, so the grazing and burning activities of settlers in the area certainly didn't make these open spaces.

People studying the grasslands have suspected for many years that they indicate particularly frost-prone country. They noted that these open stretches nearly always occur in saucer-shaped valleys. Trees grow on the sides of the valleys, and grass without trees on the flat bottoms. In each

saucer the very sharp border between grass and trees remains at a constant altitude all the way round.

In addition, the trees themselves give a clue. Common among those growing at the edges of woodlands are snow gums of the type usually found at the highest altitudes near the treeline.

These points suggest that the hard border between trees and grassland represents what is in effect an inverted treeline. But such evidence is circumstantial. More detailed investigation has been needed to clinch the matter.

As it happens, such a study was carried out nearly 25 years ago. But Dr Milton

Moore, formerly of the Division of Land Use Research, and Mr John Williams of the Division of Plant Industry have only now published the results. They concluded that the treelessness of the grasslands is indeed caused by 'lakes' of cold air trapped during winter nights in the shallow valleys.

They began their investigation by looking at all likely causes. These seemed to be fire, grazing, the soils, a higher water table beneath the grassland, and, of course, low winter temperatures.

Although fire and grazing certainly will prevent young trees from becoming established, the researchers ruled both of these out as the main cause—because of the historical records and because of the constant



Seventeen Flat—frosts seem to keep the trees off.

height of the grass-tree border.

To study the other possibilities they chose a small sub-alpine grassy plain at about 1300 metres, known as Seventeen Flat. They laid a fixed transect across the plain, and marked out 13 stations. Seven of the stations were out in the grassland, and the remaining six were in woodland on either side.

Studies of the soils beneath both the grassland and the woodland revealed no consistent differences, which eliminated this factor. Again, test bores up to 7 metres deep put in along the transect revealed no water table close to the surface of the grassland, even after heavy rain. Thus poor drainage did not seem to be causing the lack of trees on the valley floor either.

The scientists began studying how cold it gets at Seventeen Flat, using a tethered hydrogen-filled balloon. At each station they let the balloon ascend during the small morning hours in mid winter. Sensors told them temperatures at specified heights above the ground.

And a chilly pastime it must have been—the ground-level temperature at one station on a cloudless July night fell to -11°C !

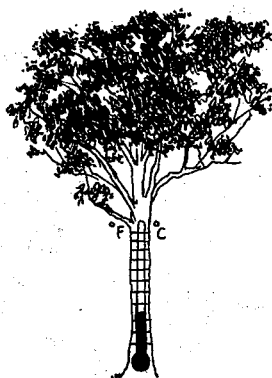
The balloon study suggested that an inversion layer formed 12–13 metres above the lowest station. On the night already mentioned, for instance, air temperatures below the layer fell to -11° while higher up they remained at a constant -6° . The inversion developed just 3–4 metres above the treelines on each side of the valley.

Having established the presence of the temperature inversions, the researchers started taking long-term measurements by placing minimum thermometers at each station on the transect. Readings taken at weekly intervals then revealed the coldest temperature experienced at each station during the preceding week.

Laboratory experiments in Canberra had suggested that seedlings of snow gum and black sally would be killed when the temperature dropped to -9° . Leaf injury would become visible at -7° .

The weekly minimum

temperature readings showed that grassland temperatures fell below these levels much more often than woodland ones. In the extreme case, at the lowest grassland station, temperatures fell to below -9° during 20 of the 31 weeks between April and December. Even at the least-cold grassland site they fell below -9° ten times. By contrast, at the coldest woodland station the temperature fell below this level only three times, and at three others it never went lower than -8° .



To test whether the winter minima really would kill tree seedlings in the field, the researchers carried out three separate plantings of several cold-tolerant eucalypt species at woodland and

grassland stations. These seedlings had been grown and hardened at Canberra.

Almost all the seedlings planted in grassland had died by the end of winter. Two black sallies that did survive died the following winter. By contrast, most of the seedlings at the woodland stations survived, although often with some damage to their leaves.

The evidence of Dr Moore and Mr Williams suggested very much that the grassland areas are indeed 'lakes' of air too cold for young trees to survive in. If natural seedlings behave similarly to the researchers' planted ones, then frequent low temperatures below night-time inversions will certainly keep the plains free of trees. But are the colder grassland conditions caused by the lie of the land, or does the presence of mature trees keep up temperatures near the ground?

To test this out, Dr Moore and Mr Williams studied another site in similar country where living woodland, dead ringbarked woodland, and open grassland all occurred close to one another at the same altitude. It turned out that the tree cover seemed to have little effect.

Burning and grazing, which were still going on throughout the experiments reported here, have now been banned for some years. A number of changes are now happening in the vegetation of the plains. These may be the result of grazing and burning having stopped. They could also be the result of milder winters. Mr Chris Harwood of the Australian National University is looking into this at present.

A study of a sub-alpine woodland-grassland boundary. R. M. Moore and J. D. Williams. *Australian Journal of Ecology*, 1976, 1, 145–53.

Cross-section of Seventeen Flat

