



Where possums choose to live

Living in the tree-tops may seem a dangerous sort of existence if the trees are likely to be cut down for the paper on which articles such as this are printed.

Yet possums, gliders, and other tree-dwelling marsupials that inhabit the extensive native forests along the southern coast of New South Wales face such contingencies. They have been the focus of community concern about the impact of logging on forest animals, and the Australian Forestry Council asked CSIRO to examine the problem.

Dr Wayne Braithwaite of the Division of Wildlife and Rangelands Research in Canberra has been studying the arboreal fauna within the woodpulp and sawlog concession area near Eden, N.S.W. The area includes 24 State forests covering 297 000 ha. Of this, 77 000 ha are closed to logging activities and 2000 ha have been allocated to pine forests. Within and adjacent to these

Inhabitants of the Eden forests — feathertail, sugar, and greater gliders and (left) two squirrel gliders.



forest areas lie a further 126 000 ha of protected national park.

Dr Braithwaite's research addressed a number of questions, including how the fauna are distributed, and what factors determine the distribution. With the answers to these, forest managers can more accurately determine what actual effects clear-felling has on arboreal animals. Of all forest animals, the tree-dwelling marsupials are most dependent on the presence of forest for their existence, making them the most likely casualties of any intensive harvesting.

Since first settlement, much of the country's forest that is important to wildlife has been cleared. In some forests also, old trees with nesting hollows have been removed to promote the growth of new trees and reduce fire hazards. In recent times the management policy has been to retain these trees; the long-term value of this practice to the tree-dwellers is not yet clear.

Dwindling timber

A logging industry has been established at Eden since 1850. The eucalypts loggers initially selected were red gum, spotted gum, grey box, woollybutt, and ironbark. As these species dwindled, and as the demand for timber increased progressively during the last 40 years — an increase caused by World War II in the 1940s, the construction of the Snowy Mountains Hydro-Electric complex in the '50s, and the growth of Canberra in the '60s and '70s — loggers harvested a wider range of trees, including stringybarks and silvertop ash.

Land-clearing for agriculture and, to a much lesser extent, for pine plantations has also been carried out for a long time; few native Australian animals have been able to adapt to life in farmland and pine forests. Then came more intensive logging, which began at Eden in 1969. Initially, foresters divided the forests into 800-ha lots that they logged intensively, clearing large areas at a time.

Public concern, at first for erosion and water quality, and later for wildlife, led to the Forestry Commission of New South Wales reducing the unit of land harvested (or coupe, from the French word *couper* 'to cut') to an average of about 16 ha, with the exception of forest cleared for pine. Coupes are logged alternately, half of them in the first 20 years of a 40-year cutting cycle and the other half in the second 20 years. The intention is that, 40 years after the first cutting, trees will be selectively taken at various times up to an estimated 160 years, when another complete felling operation will occur.

The harvesters leave strips of untouched forest 20 to 40 metres wide along creeks and leave other designated areas unharvested. In all, after the cutting cycle is completed, more than 45% of the total concession area will remain unlogged.

The Forestry Commission of New South Wales carried out a preliminary trial to determine the likely effect of a 40-year cutting cycle for pulpwood harvesting on forest fauna. The study, co-ordinated by Dr Harry Recher of the Australian Museum in Sydney, aimed at assessing the impact of the cutting cycle at representative locations in

the area. Dr Recher and his team concluded that, as regeneration after clear-felling proceeds, the young forest is eventually recolonized by mature forest fauna. But forest that is only 40 to 45 years old is too young for those species depending on mature forest for refuge, nests sites, or foraging. As mentioned above, the envisaged period between first clear-cutting and the final clear-cut is now about 160 years.

Rather than focus on the effect of clear-felling at any given place, the later collaborative CSIRO and Forestry Commission of New South Wales study attempted first to answer the question of where the fauna occurred and then to consider what had happened to forest animals at these locations.

Much of the information was obtained from the felling crews.

Dr Braithwaite and his colleagues began this research in 1980. Much of the information on the animals was obtained from the 36 felling crews, contacted at intervals of 2–3 weeks. These crews work in the Eden woodchip area, cutting up to 400 coupes annually with a total area of 5000 to 6000 ha.

The crews' felling procedure involves clear-felling coupes of forest from 3 to 30 ha according to a pre-set plan. Except where fire destroyed forest areas shortly after felling, the CSIRO team recorded data on the main tree species in representative 1/4-ha sample plots within each coupe.

Keen interest

The forestry workers have shown a keen interest in conservation of the animals. Often the felling crews could provide much detailed information on these, and in areas where fauna seemed rare they made a special effort to capture animals for identification.

Before they began the survey, the CSIRO scientists asked the crews for their impressions of local animal numbers. The CSIRO team interpreted their responses as indicating a highly patchy distribution of animals in the forests.

During the 18-month study period, the fellers identified eight tree-dwelling species in a 5010-ha area of forest clear-felled in 337 coupes. These coupes were spread over 297 000 ha.

The greater glider figured most prominently, with a count of 353 animals. Next came the feathertail glider, with a census of

Fire, slope, and fauna

Relations between occurrence of animals and concentration of leaf nutrients largely find their explanation in the marsupials' food requirements.

In 1978, Dr Turner found that nutrient levels of the leaves of individual species reflected soil nutrient levels. Two other factors — the time since a major fire and the land-form profile — also exert an effect on numbers through their influence on foliage nutrients.

Not only is much of the Eden forest sited on poor soils derived from rocks made up of low-nutrient material, but the climate of the area follows a pattern of hot dry summers — just right for wildfires. The common eucalypts here are low in foliage nutrients, and one species in particular, the silvertop ash, exhibits two seemingly incompatible attributes — high sensitivity to fire and a need for periodic fire to regenerate itself.

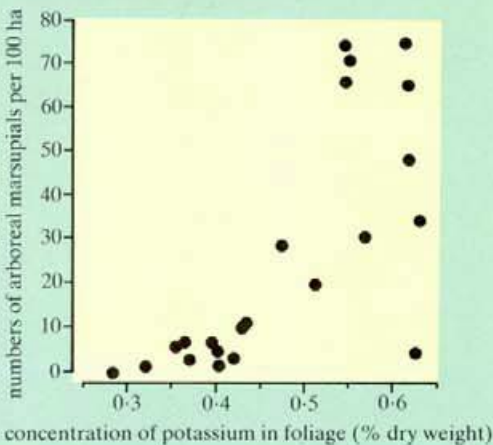
So a self-reinforcing cycle is set up, with eucalypts adapted to fire and to soils poor in nutrients perpetuating themselves in an environment prone to fire and having low soil fertility. For the creatures living in the trees, this is analogous to desert conditions.

However, the sugar glider, which is known to prefer areas that contain acacias, does live in this fire-prone environment. Acacias are a major part of the successional vegetation that grows after fire sweeps through an area. In fact, the CSIRO team's data on the relation of sugar glider density to the time since fire suggest that this glider depends more on a successional community than either the greater or feathertail glider. The feathertail glider apparently can make use of the eucalypts with low foliage nutrients that appear after severe fires.

Dr Braithwaite's data showed that sugar glider densities reached their peak about 30 years after a fire and then declined. But feathertail and greater gliders, in all the forests studied, were still increasing 35 years after a fire, close to the maximum times for which reliable records exist. Severe fire, then, apparently benefits at least two animals by providing conditions to which each is especially adapted.

The ruggedness of the terrain favoured none of the animals studied. As the largest national parks are set aside on the most rugged and mountainous terrain in a region, and mostly support low-nutrient vegetation communities, these forests may not attract many arboreal marsupials, making their efficacy in conservation of these animals doubtful.

Animal density and potassium



The density of tree-dwelling marsupials rose sharply with increasing potassium concentrations in the tree foliage.

328; then followed the sugar glider (120), the yellow-bellied glider (28), and finally, with only two reports, the pygmy possum. Five possible sightings of the squirrel glider could not be authenticated by the CSIRO researchers.

The fauna indeed showed an extremely patchy distribution. The felling crews found 63% of the total number of animals in 9% of the total area of forest sampled. Moreover, they found no animals at all in 52% (199 coupes or 2890 ha) of the area they cleared.

Presumably, not all the animals formerly present in the felled sections were sighted. In some forests, where loggers left certain species of 'non-commercial' eucalypts untouched, the numbers of animals associated with these — notably feathertail and sugar gliders — may have been substantially underestimated. On the other hand both these gliders are smaller than the other species and, when exposed during felling, fall prey to currawongs.

Koalas and mountain brushtail possums are known to occur in the forests of the Eden district, but the loggers reported none in the areas felled. The total lack of sightings of the mountain brushtail possum mystified Dr Braithwaite. Either it is highly sensitive to disturbance and leaves an area well ahead of felling operations or it spends its daylight hours in burrows or in logs on the ground, avoiding detection during harvesting.

Animal-tree associations

The research team enlisted the assistance of Dr Mike Austin, Dr Chris Margules, and Dr Nick Nichols, of the CSIRO Division of Water and Land Resources, to classify the trees in the harvested areas into 22 vegetation communities. Dr Braithwaite was then able to deduce that the tree-living animals favour communities characterized by the

presence of eucalypts known as peppermints.

Using statistical analyses, Dr Braithwaite and the late Mr George Dudzinski of the Division of Wildlife and Rangelands Research sorted the fauna according to habitat associations. Dr John Turner and his colleagues in the Forestry Commission provided information on the nutrient content of the foliage of the eucalypts. Together they found that the most important factor influencing arboreal marsupial density was, indeed, the levels of nutrients in the foliage — specifically potassium, and also nitrogen and phosphorus. Peppermints, on the whole, have high nutrient levels in their leaves.

Research elsewhere on species such as moose, deer, and grouse has indicated that these animals, too, respond to foliage nutrient concentrations. Koalas are also known to prefer browsing leaves of eucalypt species high in protein and potassium. On the other hand, Dr Braithwaite's team discovered that certain tough-leaved eucalypts, even though high in foliage nutrients, were the least preferred communities of all, presumably because of their tough texture.

The fauna showed an extremely patchy distribution.

In general, the Eden study showed that the highest density and diversity of arboreal marsupials occurred in forests containing gums and peppermints with wide trunk bases and with high foliage nutrient levels. The animals favoured forests that hadn't experienced fire for some time. Additionally, areas with a large diversity of tree species seemed to attract fauna.

What is the basis of these correlations? The greater glider is a leaf-eater that selects foliage with high nutrient levels. A diversity of species gives the animals a maximum choice of foods. The more-nutrient-rich eucalypt species are also thought to support

more insects — which makes them attractive to the insectivorous feathertail, sugar, and yellow-bellied gliders.

The presence of trees with wide trunks indicates that the stand is old — and older trees contain hollows for den sites. Further, older trees are less-frequently devastated by fire. Gums in particular are noted for the frequency with which they contain hollows.

If the fauna depend for habitat on particular vegetation types and the vegetation types depend on soil characteristics, which are in turn influenced by the types of rocks that form the soils, the next question is: what role does the soil parent rock play in animal distribution in these forests?

Soil nutrients vary significantly according to the type of parent material. A geological map of the Eden area revealed six broad categories. Matching the rock and fauna distributions showed that animals seem to concentrate in tree stands growing on granite rock formations known as Devonian intrusives, which produce the most fertile soils in this region. Thus it turns out that the forests supporting the richest arboreal marsupial fauna are also those most in demand by man for conversion to farmland or for intensive wood production.

In fact, the presence of the *Eucalyptus* species *E. radiata*, a peppermint, has historically been used as an indicator of soils suitable for pines; in the CSIRO study, this tree species was associated with the habitats most favoured by arboreal marsupials.

The other tenants

Possums and gliders are not, of course, the only animals living in woodpulp harvesting areas. In an earlier study, Dr Braithwaite, Mr Mark Clayton, Mr Leckie Maclean, and Mr Bruce Parker, all of the Division of Wildlife and Rangelands Research, examined the vertebrate animals in a 144-ha water catchment reserve near Eden.

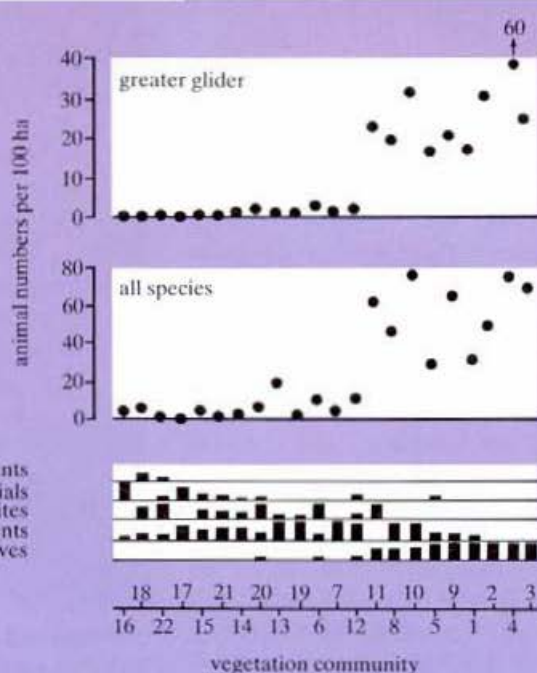
Within the Eden district, the Forestry Commission began a study of the effects of felling on water quality in half a dozen catchment systems. Because data on the vegetation already existed, Dr Braithwaite took the study as a starting point for his work on forest animals and familiarized

A study site in the Eden area, January 1978 (left), and the same site one year later after clearing and fire.



Soils, trees, and animal numbers

Tertiary sediments
Devonian alluvials
Devonian granites
Ordovician marine sediments
Devonian intrusives



The bars in the lower section show the relative proportions, by area, of each of 22 vegetation communities on five soil parent materials. Trees represented in communities 1–5 and 8–11 include mountain gum, broad-leaved peppermint, brown barrel, Maiden's gum, narrow-leaved peppermint, manna gum, apple box, and red stringybark. These high-nutrient communities grow predominantly on soils derived from Devonian intrusives, and figures from the Eden study indicate that most of the region's arboreal mammals live in them.

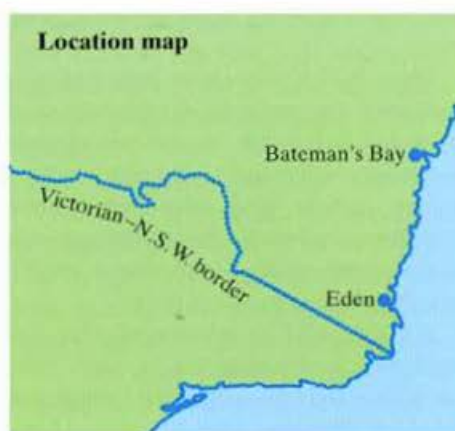
himself with ways of assessing animal abundance and habitat preferences.

He and his colleagues identified 122 species in all — eight species of amphibian, 14 of reptile, 81 types of bird, and 19 different mammals. They also recorded an extra 11 species — two reptile, five bird, and four mammal — in forest areas nearby, and at least two unidentified bat species in the study area itself.

This examination also gave an early indication of patchiness in the distribution of species and numbers of animals. And again, variation in vegetation often appeared to be the cause of uneven fauna distribution, probably reflecting animals' requirements for cover or food. Unfortunately, before the team could finish the work they planned to do on the effects of clear-felling on animal numbers in the water catchment area, fire intervened.

The evidence from the CSIRO studies suggests certain directions for management of clear-felling. Most of the forest fauna sensitive to habitat disturbance live in relatively small pockets of vegetation, which can be readily identified.

The largest areas of forest that are set aside as national parks tend to be those on the most rugged and mountainous terrain. Unfortunately, tree-dwelling marsupials



tend to be particularly scarce in such forests. There is evidence from land use surveys that most of the remaining forests of high fertility are held under private ownership, and these may eventually be cleared for farmland. In its forests of similar type, the Forestry Commission now uses less-intensive methods of logging than clear-felling and ensures, whenever possible, that reserves are set aside for the animals.

To make recommendations on the size and locations of future reserves, scientists need more information on the ecology of the fauna, especially those processes controlling population sizes. A possible solution to the conservation problem would be the shared responsibility of the Forestry Commission and the private owners whose forested land supports a significant portion of the fauna affected by felling activities.

The National Conservation Strategy report of 1982 pointed out that about two-thirds of the country's forest cover had been cleared for agriculture since the first European settlement. A considerable area of the remainder is owned privately — 34% of the New South Wales forests, and, over the whole continent, 21%. So in setting conser-

vation management goals for public lands, government authorities will need to be aware that large numbers of vulnerable animals may be disappearing in areas outside their domain.

Mary Lou Considine

More about the topic

The identification of conservation areas for possums and gliders within the Eden woodpulp concession district. L.W. Braithwaite. *Proceedings of a Symposium on Possums and Gliders, University of New England, Armidale, November-December 1983, 1984.*

Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, N.S.W. I. The species and distribution of animals. L.W. Braithwaite. II. Relationship between the fauna density, richness and diversity, and measured variables of the habitat. L.W. Braithwaite, M.L. Dudzinski, and J. Turner. III. Relationships between faunal densities, eucalypt occurrence and foliage nutrients, and soil parent materials. L.W. Braithwaite, J. Turner, and J. Kelly. *Australian Wildlife Research*, 1983, **10**, 219-29; 1983, **10**, 231-47; 1984, **11**, 41-8.

Vertebrate fauna of a 144-ha water catchment within eucalypt forest being harvested for woodpulp at Eden, south-eastern New South Wales. L.W. Braithwaite, M. Clayton, L. MacLean, and S.S. Parker. *CSIRO Division of Wildlife and Rangelands Research Technical Paper No. 35, 1984.*

Testing the correlations

Dr Braithwaite's conclusions on the habitat of tree-dwelling marsupials are being tested by his team near Bateman's Bay, north of the Eden area.

Earlier CSIRO studies had provided detailed information on the distribution of eucalypts there. Using information on nutrient content of the foliage of different eucalypt species provided by the Forestry Commission, Dr Austin and his colleagues at the Division of Water and Land Resources were able to compute an index of the potential arboreal mammal habitat for each plant community and provide a map showing where these animals are likely to be found.

This map provides a basis for testing the habitat associations found in the Eden area and shows areas with potential for conserving the animals.