health on the tireless ants of the bush, just as they in turn need the plants for food and habitat in order to continue their existence.

Roger Beckmann

Ant-plant interactions in a Western Australian wheatbelt nature reserve. J. van Schagen. Thesis submitted for Graduate Diploma in Natural Resources, 1986, Curtin University of Technology, Perth, Western Australia.

Worth preserving: the amazing diversity of native shrub species, many unique to the area, in a Western Australian sandplain heath.

The introduced pasture species capeweed, here growing in an isolated clump on old rabbit diggings that have provided the necessary soil disturbance and fertiliser.

Preserving nature amid the wheat fields

If you've ever flown over the Western Australian wheat belt you might have seen below a patchwork of regular brown wheat fields interspersed with darker patches of native vegetation. These are all that remain from the days before Europeans cleared much of south-western Australia to create the vast wheat belt.

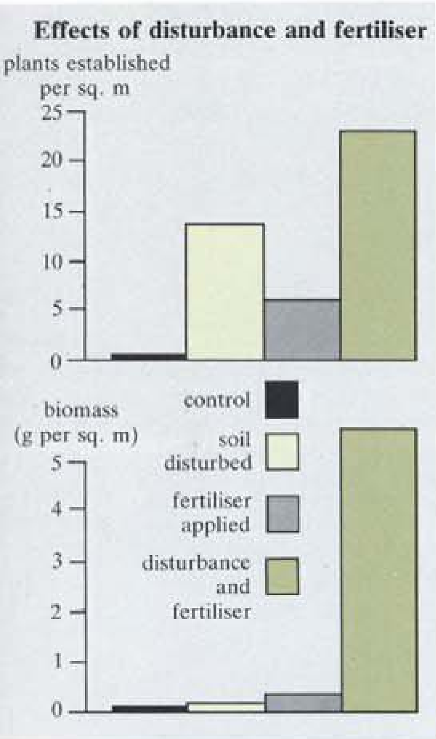
Despite the low rainfall and the sandy soils, stable plant and animal communities thrived there, well adapted to the hot, dry summers and the few months of winter rainfall.

As the land was cleared and divided into vast paddocks, small, irregularly shaped patches of vegetation remained squeezed between them, often as much by accident as design. Along tracks and roads, trees and shrubs would be left standing in swaths a few metres — sometimes even 50 metres — deep. Now these remnant patches and roadside verges have become vital in the conservation of the beautiful and unique flora and fauna that are struggling to survive in the midst of a monotonous agricultural landscape.

Staff at the Perth laboratories of CSIRO's Division of Wildlife and Rangelands Research have been studying the biology of the remnants and verges, with a view to improving our ability to manage and so conserve them. The scientists are also relating the fauna present to the vegetation characteristics, thereby hoping to identify the type of vegetation most valuable for the conservation

The natural summer understorey vegetation in a woodland of York gums near Kellerberrin, W.A. (top), and (below) a similar area heavily invaded by introduced species; the attractive native flower has disappeared.

The results of one of Dr Hobbs' experiments: the four plots in wandoo woodland are, from top to bottom, control (nothing done), fertiliser added, disturbance and fertiliser, and disturbance only. Introduced annuals have been successful only in the plot that incorporated both soil disturbance and fertiliser.



Fertiliser and disturbance together had a dramatic effect on establishment of the introduced weed *Avena fatua.*

of native birds and mammals, and allowing us to concentrate conservation efforts on that.

A major question being investigated is whether natural plant communities are being invaded and taken over by introduced species, and if so what factors allow this to happen. Dr Richard Hobbs, a plant ecologist with the Division, has been concentrating on this. He examined five different communities of natural vegetation near Kellerberrin in the wheat belt.

He wanted to know whether two factors common in the region would have any effect on the ability of weeds to establish themselves and take over natural communities. These are soil disturbance, caused on a large scale by agriculture or on a smaller scale by rabbits and other animals; and fertiliser, which may often find its way into natural areas from nearby agricultural ones, or also be provided in the form of rabbit faeces.

So Dr Hobbs conducted an experiment in the field using seeds of two introduced weeds — *Avena fatua*, an annual grass and common pastoral species, and *Ursinia anthemoides*, a forb. Both are widespread in south-western Australia. The scientist and his assistant scattered known numbers of seeds in marked plots in May, and counted established seedlings in June and July.

The experiment created four different environments: a control plot had nothing done to it; a second plot was fertilised using a slow-release compound; in another, Dr Hobbs disturbed the top 5 cm of soil; and, finally, a fourth plot received both disturbance and fertiliser. He carried out these different treatments in plots within five different communities, ranging from heathland and scrub to woodland.

Results showed that introduced weeds need some soil disturbance before they can establish themselves in any quantity in the native plant communities in that area. Once established, they don't necessarily always flourish, but can certainly get by.

However, if fertiliser is present along with soil disturbance, then the weeds really become successful (see the charts). The fertiliser allows them to grow faster and to produce more seed. Of course, the fertiliser also increases the growth of some native species, but the introduced species present may prevent the successful regeneration of shrubs and trees.

In case you feel that Western Australia's shrubs are wimps, it's worth pointing out that wheat-belt soils are nutrient-poor, and growth of all plants there is nutrient-limited. The native plants have adapted to this, whereas introduced species are often used to higher nutrient levels. Allow our plants to compete on their own terms — that is, without any fertiliser — and they will usually win.

Dr Hobbs also found that the factors necessary for the weeds to be successful differed in the five communities. In one woodland area, the introduced plants were as successful in the 'fertiliser only' plots as in those with 'fertiliser plus disturbance', which was not the case in the other communities. He believes the reason may be that the surface soil crust is not as well developed in the woodland as in the other communities studied, and so the weeds didn't need disturbance in order to gain a start.

He also observed that, outside his experimental plots, introduced annual weeds were more abundant in woodland than in shrub communities, despite the fact that the exotics' seed was entering both communities — which he proved using sticky seed-collecting dishes with a bird-repellent gel. The differences in 'invasibility' between the communities is something that Dr Hobbs hopes to investigate further.

But meanwhile, what is the significance, or indeed importance, of all this? Scientists believe that the problems with salinity now experienced in the wheat belt are a direct result of removing native vegetation, which, on a large scale, plays a vital role in regulating the water equilibrium of the area. (The Division is researching this problem too.) And the more we know about 'invasion' the better we may be able to manage the small reserves of native vegetation that remain.

Then, consider the small patches of native vegetation that constitute roadside verges. They have aesthetic importance for the road-user, practical use as windbreaks, and economic importance for the tourism trade (because many people see all the West's famous wildflowers from a car window). The loss of native flowering shrubs and their replacement by unattractive introduced weeds is obviously to be avoided if possible.

Perhaps even more important than aesthetic considerations, grassy weeds are a fire hazard.

They can grow so fast as to swamp native tree seedlings. Already very few young trees are growing in the verges. This may be due to many factors, including low seed production or the possibility that regeneration of the trees only occurs in widely spaced episodes anyway. Certainly a thick cover of non-native grasses is likely to inhibit any tree regeneration. Loss of trees in the verges will, of course, increase the likelihood of soil erosion, and then very little will grow there at all.

A road verge in the Western Australian wheat belt with sparse native shrubs and heavy invasion by introduced annuals.

Finally, the verges may act as 'corridors' for animals to pass from one small patch of remnant vegetation to another. Many of the remnants seem to be too small to maintain self-sustaining, viable populations of vertebrates. Migration through corridors allows some mixing, and so prevents stagnation of an isolated small gene pool.

A survey of roadside verges by Dr Graeme Arnold, working with Dr Hobbs, and Dr David Algar of the University of Western Australia has shown that, while many non-native animal species use the verges, our native echidnas, western grey kangaroos, and euros do too, presumably to move between the fragmented reserves. Further studies, using radio-tracking, are planned to confirm this.

The scientists' observations so far suggest that, apart from their possible use as corridors, narrow verges are too small to be of use *per se* in the conservation of small native mammals, but they do have considerable value for small birds. The researchers recorded a total of 41 species of birds in the verges over a 6-week period, although many of these were seen only once or twice in one or two sites.

The verges' importance to birds lies in providing shelter for the smaller ones and also, when native plants are flowering, a food source for many species. Dr Denis Saunders, also of the Division, is carrying out further work to assess the extent of the use of roadside vegetation by birds moving from one reserve to another.

One of the main aims in studying patches of remnant vegetation is to enable us to better manage them as conservation areas. If we can find out more about why some communities are more 'invasible' than others, we may be able to implement ideas that will help in the preservation of the native flora, which in turn will be important for the survival of the West's native animals.

Roger Beckmann

The effect of disturbance and nutrient addition on native and introduced annuals in plant communities in the Western Australian wheatbelt. R.J. Hobbs and L. Atkins. *Australian Journal of Ecology*, 1987 (in press).

What size electrostatic precipitator?

Electrostatic precipitators allow power stations to burn coal while emitting scarcely any fly-ash out of their chimneys. Modern units can catch more than 99% of the fly-ash as they electrically charge the particles and pull them out of the smoke stream towards earthed metal plates.

A problem, though, that has perplexed designers of electrostatic precipitators for many years is to know how big to build the unit. If it's too small, statutory emission limits are violated; too big, and unnecessary cost (we're talking millions of dollars) is incurred.

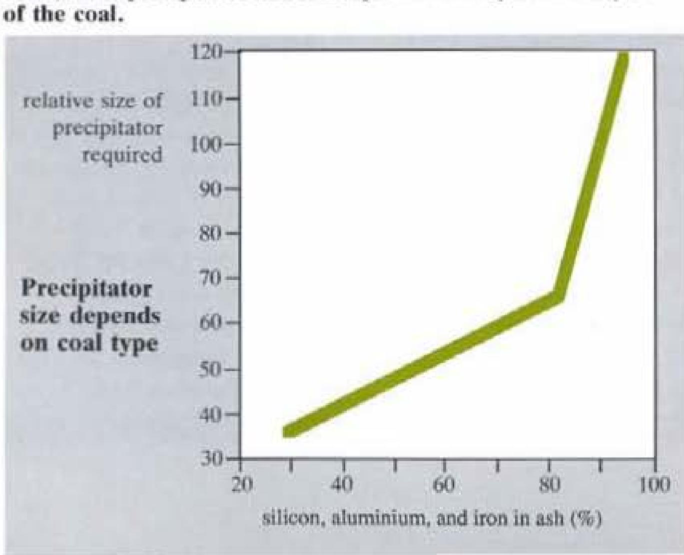
The difficulty relates to the many variables involved in the operational efficiency of an electrostatic precipitator. It all depends on the chemical and physical properties of the fly-ash, its amount, and the degree of removal required. For identical performance, units may differ in size by a factor of seven to accommodate different kinds of coal.

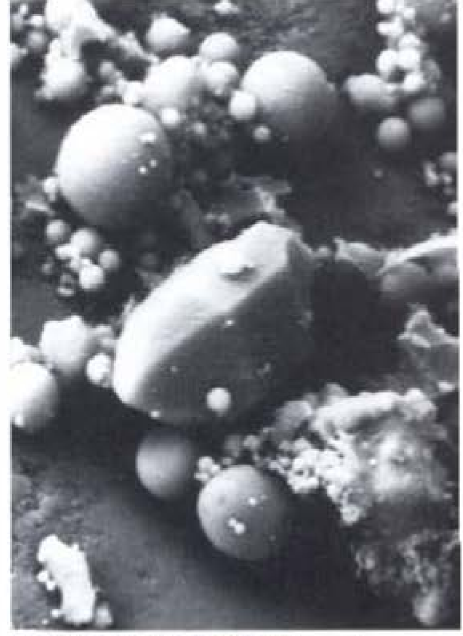
Precipitator designers have often had to rely on a more-or-less satisfactory blend of past experience and intuition. Fortunately, they have been helped by research at the CSIRO Division of Fossil Fuels, where Dr Edmund Potter and colleagues have investigated the principles governing precipitator performance. And, since 1969, the researchers have used a combustion rig at the Division to measure the ease of precipitating fly-ash from different types of coal.

Now the researchers have discovered that they can make the task of sizing a precipitator much easier. After burning some 33 eastern Australian steam coals in the test rig, they have found a simple formula that relates the size requirement of a precipitator to readily measured constituents of the coal.

As the graph shows, the size of the precipitator required depends very closely on the total quantity of silicon, aluminium, and iron present in the ash — figures that can be obtained by routine chemical analysis. The correlation is sufficiently good that calculations based on it yield precipitator sizes accurate to within 10 per cent — quite adequate for practical use, bearing in mind the operational fluctuations that all precipitators experience.

The two straight lines, derived from tests on dozens of steam coals, allow precipitator size to be specified solely from analysis of the coal.





Fly-ash particles under the microscope.

The correlation holds for all coals tested in which up to 90 per cent of their ash consisted of silicon, aluminium, and iron. For a few of the 33 coals, where these three elements were present in unusually high percentages, the correlation faltered, presumably because the electrical resistance of their ashes was so high that a phenomenon called 'back corona' occurred. In these cases, there is no substitute for combustion rig trials, a technique that has gained international acceptance.

The now largely superseded rig trials required, for each coal, 1–2 months of work for best results. Where the new-found correlation can be employed, the required information can be obtained in a fraction of the time and at much reduced cost.

Andrew Bell

Correlation of some readily measured parameters of coal and fly-ash with electrostatic precipitator performance. C.A.J. Paulson, E.C. Potter, and J.S. Vale. *Proceedings, Seventh World Clean Air Congress, Sydney, August 1986.*