Fire damages top-end forests

Tall open forest that is burnt annually by early-dry-season fires (left) contains very few saplings, mainly coppice shoots. By contrast, the photo on the right shows how young trees shoot upwards in tall open forest protected from fire for 3 years. The two sites are immediately adjacent to one another.

For 6 years Mr Jamie Hoare of the CSIRO Division of Forest Research has studied the effects of fire on the tall open forest and woodland of the Kakadu National Park. He and his colleagues have found that high-intensity wildfires, resulting from European habitation, have significantly damaged these plant communities.

If the fires continue to burn as they have, the scientists believe the trees, and the ecosystem of which they are a part, will be severely degraded within 50 years. The area could well change from tropical forest to scrub.

The study region is typical of about 80% of the Kakadu Park and of more than 5000 sq. km of similar country surrounding the Park.

Of course, fire has always been a dominant force in the delicately balanced ecology of the region. The species that exist in tall open forest and woodland have, over thousands of years, developed a high resilience to it. Any fire-sensitive species would have died out long ago. The survivors have developed protective mechanisms; for example, eucalypts have thick fire-resistant bark and an ability to sprout again from the trunk or stump.

(The patches of monsoon forest in the region present a different picture. Fire burns their edges and whittles them down, a process that has probably already wiped out some smaller patches.)

Fire is therefore unlikely to immediately threaten the survival of any species in the tall open forest and woodland. Indeed, Mr Hoare found that the severity and frequency of fire in a particular area had a negligible effect on the number of plant species found there. However, all this is not to say that fire is an agent of no consequence.

Excessive amounts of fire inhibit the full expression of a species' growth potential.

The point is that an excessive amount of fire inhibits the full expression of a species' growth potential. It can result in a tree acquiring a multiple-stemmed coppice form and being unable to grow to its full mature height. Under these conditions, when the aged trees die the plant community loses its top storey. A scrub of low coppice shoots remains, and without a protective tree canopy the whole ecological balance, of plants and animals, is upset. In the long term, the extinction of species is quite possible.

Since European settlement of the Northern Territory, the severity of fire has increased dramatically. High-intensity fires late in the dry season occur frequently — as often as once a year. In the main, they are lit by people wanting to open up the bush for better access. Pastoralists and buffalo-shooters are probably the most common ones involved in setting off these clearing burns.

After 6 years, the forest floor is covered with leaf litter, not sorghum.

By contrast, in the past Aborigines used fire when they were on the move, usually at the beginning of the dry season when they moved on from their wet-season camps. The country is much less flammable at that time of year, so the fires were not nearly as intense.

Today, the result of 100 years of repeated clearing burns is that recruitment of young eucalypts into the overstorey has been seriously disrupted.

Mr Hoare can see the change in the forests and woodland happening, although it is a slow process because of the eucalypts' longevity and remarkable resistance to damage by fire. He points out that the

tall open forest in the area has two distinct layers. A relatively high tree canopy occupies one layer, from 15 to 19 metres, and an understorey layer restricts itself to less than 1 metre. The mid storey, which in healthy forests contains saplings, is notably absent.

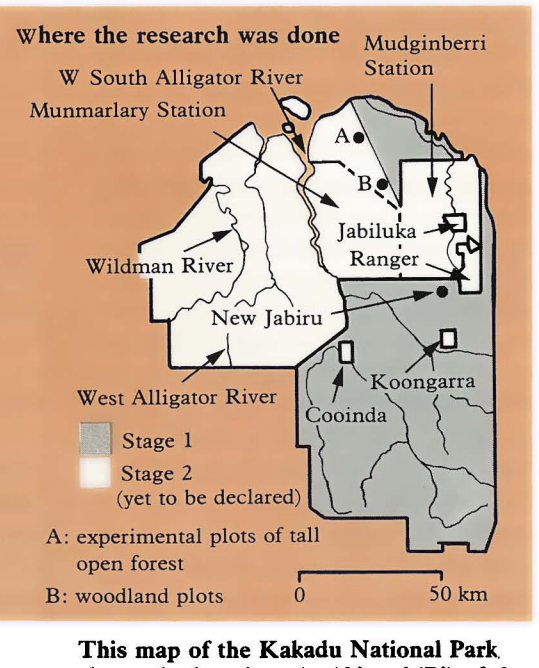
The crowns of the aging tall trees are above the ravaging flames. Small trees are defoliated, but they can spring up again from their lignotubers. But saplings of medium height cannot get established. And within the next 50 years, Mr Hoare estimates, most of the old trees could well have died of old age.

A controlled experiment

Mr Hoare's findings emerged from the first 6 years of a study of an area containing tall open forest and woodland near Munmarlary Station, which is in Stage 2 (yet to be declared) of the Kakadu National Park. The area is removed from cattle-raising regions, but indirectly it suffers, like much similar country, from the fires that spread from human activities.

Numbers of 1-ha plots were surveyed, and surrounded by bare-earth fire breaks. Each plot was subjected to a different fire regime, and the effects on the forest and the woodland closely monitored. (The distinction between the two is largely arbitrary, but in general the woodland eucalypts are smaller, include more species, and are more widely spaced.)

The research has been undertaken by Mr Hoare and his colleagues at the CSIRO Division of Forest Research — Mr Phil Cheney and Mr Kris Jacobsen — and Mr Ron Hooper of the Conservation Commission of the Northern Territory. The Australian National Parks and Wildlife Service has contributed funds towards some aspects of the work, including the cost of publishing the profusely illustrated report.



This map of the Kakadu National Park shows the locations (at 'A' and 'B') of the experimental plots.

When the aged trees die, the plant community loses its top storey.

The experiment effectively began in September 1972, when all the plots were deliberately burnt to provide a uniform starting point. However, as in most experiments, not everything went according to plan, and in 1974 wildfire burnt out a number of woodland plots. Although unfortunate, this event luckily didn't cause too much disruption.

Ideally, the researchers wished to impose the following fire regimes.

- EARLY-DRY-SEASON ANNUAL BURN. Carried out in May or at the first opportunity in the dry season, this reflects the practice of Aborigines as they shifted from their wet-season camps. The fire causes minimal damage; it spreads at about 5 m per minute, with flames mostly 1·5 m high or less.
- LATE-DRY-SEASON ANNUAL BURN. Carried out in late August, this is intended to represent wildfire — that is, the way much of the area has been burnt in the last 100 years. High fire damage results from flame heights of up to 8 m and rates of spread of up to 30 m per minute.
- EARLY-DRY-SEASON BIENNIAL BURN. Accumulated litter helps still-greenish grass burn steadily, but the fire does little damage to trees.
- NO BURN. This provides a comparison.

Apart from the disruptive wildfire, and some variation from the expected intensity of some burns, the experiment went according to plan.

Tall open forest

The top storey of the tall open forest in the study area was dominated by *Eucalyptus tetrodonta* (56%) and *E. miniata* (25%), with scattered *E. porrecta* (19%). The average height was 13 m. About 20 species of palms, small trees, and shrubs formed a low understorey.

Before the experiment started, some 95% of the understorey vegetation (counted as the number of stems, but ignoring grasses) was less than 1 m high (80% 0–50 cm high and 15% 50–100 cm). Only 5% of it exceeded 1 m.

Grasses were abundant, mostly tall, and patchy in occurrence. They were mostly annual sorghums, which form a dense and stalky community about 2 m high. In the dry season they become dry and tangled, forming a highly flammable fuel.

Significantly, the trees occur in irregular clumps, with sorghum dominating the areas between the clumps. Mr Hoare supposes that the sorghums help maintain this situation by their fierceness of burn, which defoliates any regenerating trees.

The clumps provide relatively safe refuges from fire, where protective canopies of shade discourage the tall annual grasses and shorter ones grow instead. Less fuel is therefore provided for fire, with the result that fire damage is less and the forest may get some chance of growing.

Too much fire

However, results of the experiment showed that even the clumped zones were experiencing too much fire for their own well-being. The most convincing evidence for this comes from the changes in those plots completely protected from fire.

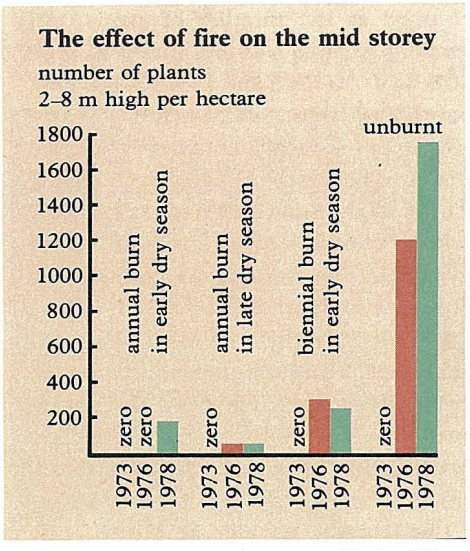
In the area from which fire was excluded for just 5 years, the tall open forest developed a multi-layered structure above an almost continuous thick mat of leaf litter and twigs, with considerable growth and regeneration of all species.

The vital process of recruitment of species into the upper layers, which had previously been suspended, recommenced. The renaissance of vegetation included the development of vines, with one species climbing some metres up into the understorey. *Pandanus*, which is most frequently found in tropical rainforest, also began growing in the unburnt plots.

Parallel with the increased complexity of the vegetation structure, the numbers of birds and animals frequenting the area also increased.

The forest micro-climate, and growing conditions on the forest floor, changed. As conditions became darker and moister, small grasses replaced sorghums, although the latter still survived in places.

The increased vigour and health of the unburnt areas can be demonstrated numerically in a most vivid way. Fire suppresses the upward growth of juvenile eucalypts and confines them to a low coppice habit (less than 1 m tall) in which many stems shoot up from the ground. Plant 'clones', consisting of groups of up



The chart shows the severe effect of fire in preventing the growth of a mid storey in tall open forest.

to 20 or more coppice shoots, are formed, with all the stems originating from a common underground root system. The clones can spread over a considerable area.

After 5 years, the plots given a late-dry-season annual burn (where fire intensities were highest) contained 533 clones per hectare. This compares with 233 per ha in those given early-dry-season annual burns, 67 per ha in the plots burnt biennially early in the dry season, and 33 per ha in the unburnt section.

Woodland

The effects noted above for the tall open forest could also be observed in woodland areas.

The grass burns in a flash, giving an intense damaging heat.

Woodland showed somewhat greater structural diversity (all vegetation layers were occupied, although 89% of the understorey and mid storey was lower than 1 m), but fire damage was more severe.

The lower average height of the woodland overstorey (about 10 m) brings heat-sensitive canopies into closer contact with fire. Grasses grow more freely in the open woodland, giving rise to more intense fires. At the start of the experiment, the researchers saw many trees with fire scars, dead tops, mis-shapen branches, and epicormic and coppice growth. They counted a remarkable 734 clones per ha.

Again, when fire was excluded from the area, the woodland responded with dense regeneration and growth of eucalypts, other evergreens, and deciduous trees. Clones declined to 100 per ha with biennial burns and to 33 per ha with early-annual and no-burn treatments.

Towards recovery

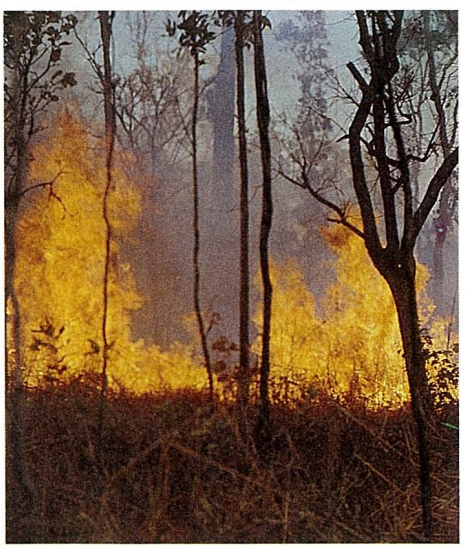
The experiment has confirmed that the annual cover of long grass, accompanied by an absence of litter, in areas burnt late in the dry season tends to perpetuate that same highly flammable condition. The grass burns in a flash, giving an intense damaging heat. Hot fires prevent recruitment to the overstorey and renewal of canopy cover, leading to conditions favouring more grass and more hot fires.

On the other hand, when burning takes place in the early part of the dry season, the fire invariably causes less damage and, as a result, a litter cover begins to accumulate, replacing the annual grasses. Fire damage is then reduced even further because leaves and twigs burn more slowly and less fiercely than grasses.

Furthermore, the fire goes through at a time when the soil is moister, favouring the survival of trees under stress. The survival of aged, weak, or damaged trees is endangered if they are defoliated under prolonged drought conditions.

Renaissance

The reappearance of vegetation in the 2- to 8-m layer is the vital sign. Late-season fires stop this growth almost totally. The experiment shows that early annual burns, timed to give low intensity, allow some mid storey development. Biennial burns early in the dry season allow more such growth response. However, the true potential for regeneration shows up only when fire is excluded for years at a time.



Sorghum burns fiercely late in the dry season. The fire damages other vegetation, notably young saplings.

Sorghum dominates the ground cover in this woodland area burnt annually early in the dry season.

A more diverse understorey appears when woodland has been protected from fire for 3 years.

Of course, the accumulating litter — leaves, twigs, and branches — gradually produces an increasing fire hazard. If this is left alone, ultimately wildfire will totally ravage an unburnt area, and all the gains in forest structure and diversity will be lost.

Mr Hoare estimates that burns conducted every 4 years (approximately), early in the dry season and under carefully prescribed conditions, would give the area the chance it needs to recover. They should also maintain the wildfire risk at an acceptably low level.

The Australian National Parks and Wildlife Service is examining ways to implement the study's findings. From their present run-down condition, Kakadu's open forests and woodlands could, with careful management, regain their former tropical splendour. However, the outlook for similar areas outside the sanctuary of the Park is considerably bleaker.

Andrew Bell

More about the topic

'A Report on the Effect of Fire in Tall Open Forest and Woodland with Particular Reference to Fire Management in Kakadu National Park in the Northern Territory.' A report to the Australian National Parks and Wildlife Service. J. R. L. Hoare, R. J. Hooper, N. P. Cheney, and K. L. S. Jacobsen. (CSIRO: Canberra 1980.)