THE DIEBACK CRISIS — TREE DECLINES THROUGHOUT THE WORLD

by Meg Lowman

"There are some who can live without wild things, and some who cannot. Like winds, and sunsets, wild things were taken for granted until progress began to do away with them. Now we face the question whether a still higher 'standard of living' is worth its cost in things natural, wild, and free."

Aldo Leopold, *A Sand County Almanac,* 1949

Since the popularity of Crocodile Dundee, tourists are flocking to Australia to enjoy the wide open spaces and beautiful landscapes portrayed in the tourist magazines. But those who drive north of Sydney (or west or south . . . you can not drive east because of the Pacific Ocean) are greeted by a dying landscape. The muted, delicate colors of the Australian countryside give way to the whitened skeletons of trees with dead branches, raised toward the sky as if in supplication. Cattle stand beneath trees which have lost their leaves and no longer cast shade. It is a harsh, exposed landscape.

Dying eucalypt trees in Australia

The sickness of the trees is known as "dieback" (definition: mortality of trees caused by a host of causes, some apparently inexplicable, but most stemming from human disturbance to the environment). Giving the malady a name merely provides a means of talking about it. It does not cure it nor explain it. Neither the cause nor the treatment of this ecological disaster is currently well understood despite the considerable attention paid to it. It is an exceedingly complex problem; one which will require a long time, much money, and a sustained, intensive scientific effort to unravel. It is also a race against time. It is not enough merely to understand, but to understand in enough time. While people are rightfully concerned about AIDS, and about the levels of pollution in water and air, we often neglect the health of our landscape, in particular the trees, "natural" cleansers of air, water, and soils.

Unfortunately, efforts to reverse tree declines can not come from years of planning or good intentions in the classroom; we need field research *now.* This must involve students, researchers, and conservationists. Policy makers can revise plans, historians can analyze trends, but no one can effectively replant trees unless the biological research has been completed and the physical environment will sustain regeneration. Dr. Seuss summarizes it very well in his book, *The Lorax!:*

> It's a Truffula Seed. It's the last one of all!
> You're in charge of the last of the Truffula Seeds.
> And Truffula Trees are what everyone needs.
> Plant a new Truffula. Treat it with care.
> Give it clean water. And feed it fresh air.
> Grow a forest. Protect it from axes that hack.
> Then the Lorax and all of his friends may come back.

Change in the landscape is inevitable. If one were to take any part of the world's surface and employ time-lapse photography over millions of years, one would find that a particular region changes from forest to desert, is covered by shallow sea, is raised into mountains which subsequently weather away, and so on. These changes are long term. They are scarcely perceptible within the lifetime of a single generation and may even go undetected during the short period of time we have been on this planet. Change becomes alarming, however, when within just a few decades, a few years, or even shorter periods, one can see the death of the vegetation covering an area and the marked deterioration of the landscape. The very fact that the causes are so often unknown makes such a situation even more disturbing. Almost no region of the world is exempt from tree decline or dieback. The Sahara Desert, the outback regions of Australia, the conifer forests of Europe, the deciduous trees of eastern North America, and now the edges of tropical forests in central America are subject to dieback, threatening food, shelter, and even climate.

What Is Dieback?

Dieback is best defined by its observable symptoms. Those symptoms can be grouped into stages of increasing severity. The first stage is decline and thinning of the tree crown, beginning at the tips of the twigs and progressing along the branches toward the trunk. As the outer parts die the dead ends of branches protrude beyond the live remaining foliage (Fig. 1). Once there has been considerable decline of the crown, new shoots (epicormic shoots) may be

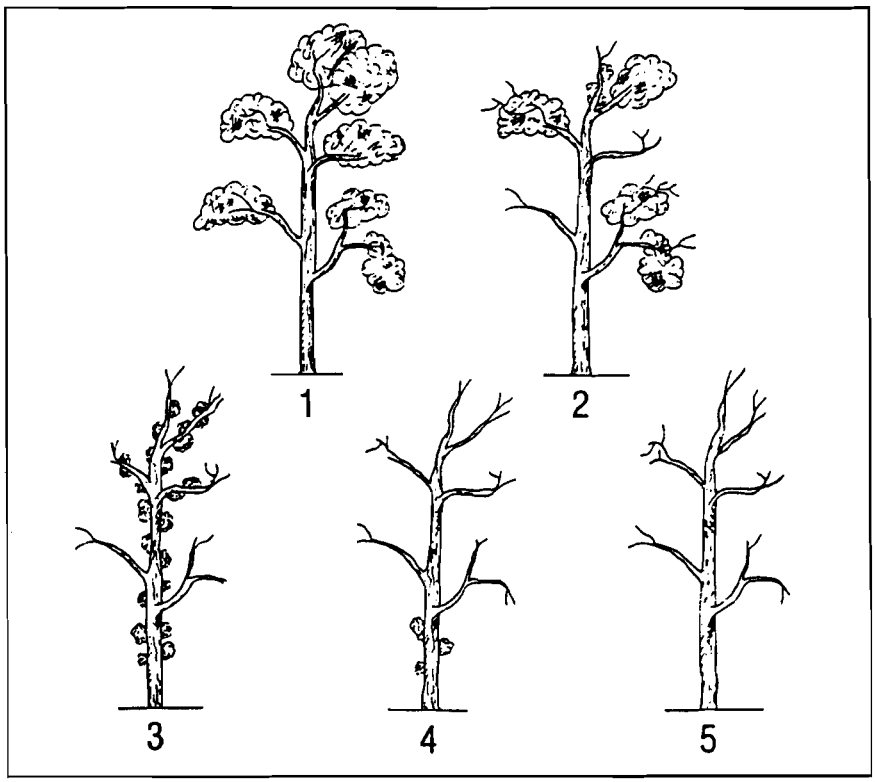

Figure 1 — Dieback of trees occurs in several stages. Stage 1 is a healthy tree. Stage 2 shows the foliage beginning to die from the tips of the branches toward the trunk. There are dead ends of branches protruding beyond the live foliage and there are some completely dead branches. In Stage 3 many branches are dead, but the trunk and base of major branches produce new epicormic growth. By Stage 4 most of the epicormic foliage has died; finally, Stage 5 represents the death of the entire tree. Recovery can take place from any stage except 5.

Heatwole, H. and Lowman, M., 1986 *Dieback - Death of a Landscape,* Reed Books, Sydney.

produced directly from the trunk or main branches. If conditions become favorable for regrowth, some species of tree can resprout a healthy crown from epicormic shoots; others continue to exhaust their metabolic reserves until death.

In Australia, dieback is caused by a complex of factors, including: insect defoliation; fungal diseases; drought; alteration of water tables; nutrient imbalances in the soil caused by application of fertilizers; soil erosion and reduced soil aeration; clearing of land with retention of old trees but not saplings; overstocking with grazing animals; salinity; and clearing of adjacent trees. In other countries, pollution can be added to this list (contaminants of air, water, soil), as can logging and even such natural phenomena as lava flows, volcanic ash, and climatic extremes.

It is unlikely that any one of these suggested causes is solely responsible for Australian dieback. It is more probable that combinations of several factors are involved, or even all in concert, and there may be additional causes not yet detected. A further complicating factor is that tree declines may result from a combination of causes that vary among years. For example, drought may be important in one year, but in another, insect grazing may be the predominant problem. A particular factor may be causal only in intermittent years. Thus, research must continue over a long period to quantify the causes of tree declines.

A further complication arises when two different causes interact with each other to produce an effect different from the sum of their effects when operating independently — a phenomenon known as "synergism." For example, a particular amount of defoliation may have a very different influence on tree health during drought years as opposed to wet years.

Once the causes of tree declines can be quantified by scientists, the malady is not necessarily reversible. Further research on tree restoration is equally important to reverse global tree declines. In many regions of the world (e.g. deserts, cleared rain forest tracts) re-afforestation is proving very difficult, almost impossible. The consequences of this are not yet fully measurable in terms of long term global climate and environmental stability.

A Geographic Survey of Dieback

Since I left Williams in 1976, I have been studying forest ecosystems in different parts of the world. In every region, tree declines were evident and quite horrifying. Even in the northeast of the United States, gypsy moths and other insect pests are threatening the very trees prolific in urban landscapes. Not all diebacks are identical to those in Australia, but they all have two common properties: the causes are not well quantified and the end result is always a landscape without trees.

There have been at least three major causes of tree death in Europe: widespread industrialization of the continent, creating "acid rain" that has killed extensive evergreen forests in Germany and other countries; insect attack, such as the caterpillar outbreaks in Scandinavia; and fungal diseases, such as Dutch elm disease. In Africa, many forested areas have been cleared for agriculture, and subsequent attempts to re-afforest them have been unsuccessful. Even worse, the edges of the Sahara desert are expanding, causing severe erosion problems in areas that historically had trees.

In the tropics, the logging of rain forests has resulted in extensive tracts of cleared land, with accompanying problems of erosion, landslipping, and flooding. Logging

obviously causes direct tree death, but it also results in two more indirect problems. First, it is often difficult (even impossible) to regenerate trees after the primary forest has been logged because many tropical trees grow best in the shade of bigger trees, and also because the mature trees provide nutrients for the soils and serve to reduce erosion and drying effects. Secondly, trees on the edges of cleared areas usually suffer dieback, even though they have not been logged. The conditions on the edge of a clearing are vastly different from the shaded, windless, forest interior that existed previously, so edge-trees suffer dieback from drought, dessication, and even attacks of insect pests that have invaded the clearing. Regeneration of primary forest is estimated at hundreds, even thousands of years, in these logged sites.

What about North America? Surely, one would expect that countries with advanced technology and a strong conservation ethic would be able to reverse their tree decline. However, this is not the case. Since the early part of this century, North America has experienced repeated tree declines. The chestnut blight was one of the first major declines documented in American forest history. The elm decline followed in its wake. In both cases, it is speculated that people were responsible for the introduction of the fungal vector from Europe. Two more recent examples of this are the gypsy moth and oak gall wasp infestations of the 1980s. Several more insect pests are predicted to emerge during the 1990s.

Some widespread tree declines of the twentieth century do not appear to be directly related to fungi or insects. Entire forests in the eastern United States are undergoing severe growth slowdowns and sometimes mortality, hypothesized to be the result of acid rain. Air pollution may affect tree growth in several ways. Ozone may open the pores of leaves, thus allowing acid rain to cause internal damage. Acid rain may also deposit toxic metals directly on the leaves or in the soil, where they cause damage to the roots. Many rural regions of the northeastern United States now have abnormally high levels of copper, zinc, nickel and cadmium in the soil. Just as with biological dieback syndromes in Australia, industrially-related dieback in North America appears very complex. Its effects are varied and perhaps synergistic.

The American diebacks relate to human activity in two ways. First, the establishment of trees in plantations of a single species has exacerbated the problem of insect and fungal outbreaks. Second, industrial activities appear to have created air pollution and acid rain that in turn causes widespread dieback in upwind rural woodlands and forests, especially on mountain tops.

In Australia, I have spent five years studying insect defoliators and their implications in the eucalypt dieback syndrome. Eucalypts, with over 500 species, are the major genus there although many have been cleared for agriculture. The remaining trees, in part because they are scattered and in part because of synergistic effects with other components of their ecosystem, are suffering dieback and inevitable death. My role in solving this problem has been to climb trees (lots of them!) and measure the impact of insects on the canopies. The defoliation of leaves by insects appears to be the last straw in a number of stresses that lead to mortality. Now that we have established the relative importance of factors in dieback, more research is in progress to determine the methods (if any) for regenerating trees on the hot, dry, overcleared pastures — not an easy task. As in many aspects of environmental science, progress is impeded by lack of funds and, in the case of Australia, lack of manpower.

What Can Be Done?

There are still some outbreaks of dieback that remain a complete mystery. In 1964, high mortality swept through 16,000 hectares of apparently healthy eucalypt regrowth forest in Tasmania, with no cause ever pinpointed. In many regions of Australia as well as in other countries, causes remain speculative, but funding for research to quantify the vectors is inadequate.

There is a long term and short term answer to the dieback dilemma, both of which are critical to sustaining the tree cover on Earth. The long term solution involves continued research on forest ecosystems and their perturbations. Ecosystems are poorly understood, particularly with regard to the interactions of their organisms. One needs to know enough about ecosystems to be able to predict what will happen if certain land use changes take place, not wait to see what *does* happen and then try to rectify the damage. The short term approach is to take immediate measures to lessen the undesirable effects of dieback in particular regions. One cannot wait until the dynamics of an ecosystem are fully understood before ameliorating extreme situations. Mistakes will inevitably be made, but hopefully much will be learned from them, particularly in the case of tree restoration activities, which are poorly understood in most disturbed sites and must be conducted almost on a trial-and-error basis.

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Dieback is an ecological illness of great magnitude and enormous complexity. And it is the result of a variety of causes. It was not deliberately brought about by human activity, but in many cases the pattern and intensity of land use appear to be an ultimate cause, abetted by secondary factors such as insects, fungi, and drought. Each of us shares the blame for having neglected and abused our environment and ignored signs of its deterioration until it has reached disastrous proportions. Together we all — scientists, farmers, economists, foresters, land managers, politicians, and taxpayers — need to bear the responsiblity for arresting tree declines and regenerating landscapes throughout all continents. Hopefully, innovative research and knowledge of replanting techniques will enable us to reverse this malady. We need more young and energetic scientists to address this issue!

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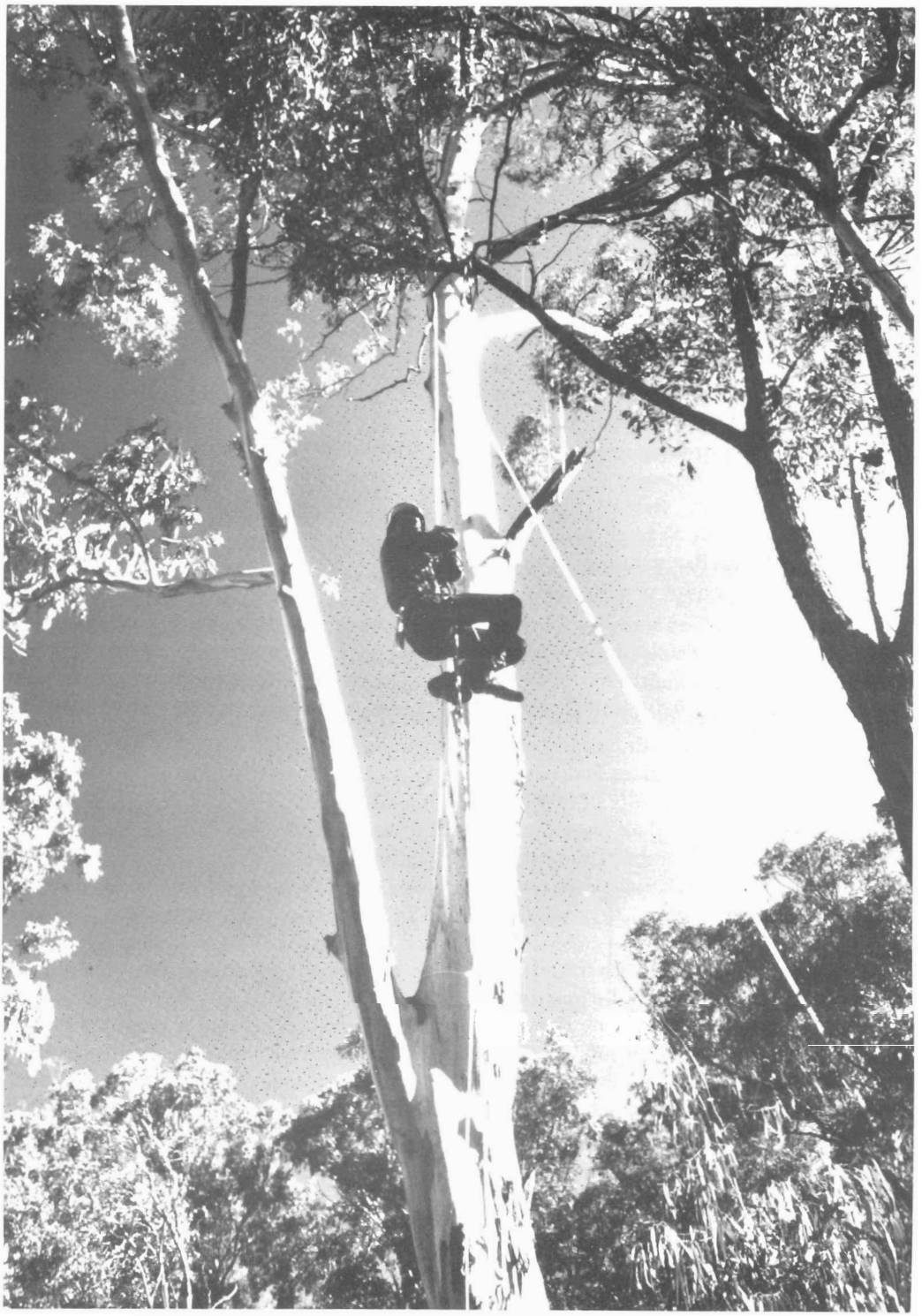

The author, in the trees