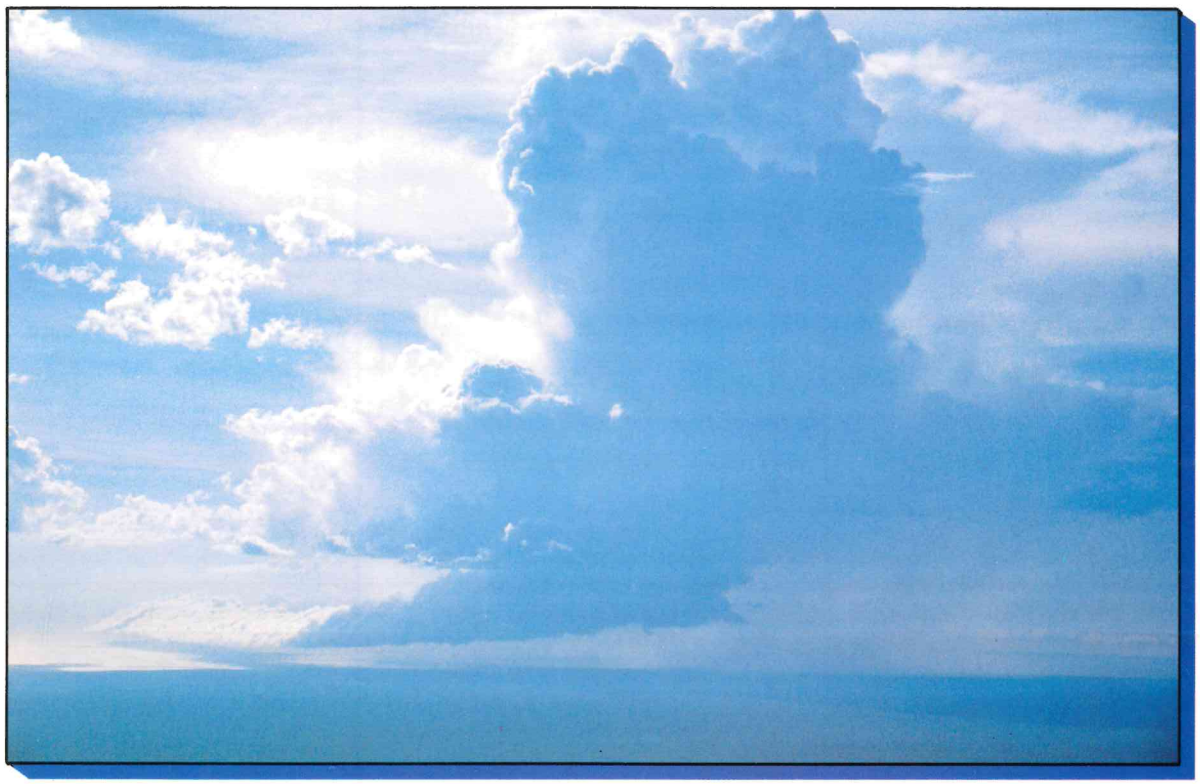
GREENHOUSE AUSTRALIA



Cliff Winfield

Hardly a day passes without an article in the newspapers about the greenhouse effect or the ozone layer. Apart from leaving you vaguely alarmed, you may not be much wiser. What is the greenhouse effect? Where, and what, is the ozone layer? What are the problems,and what is being done about them? JOHN BLYTH, from CALM and PHIL NOYCE, from the COMMISSION FOR THE FUTURE, give you up - to-date answers.

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THE greenhouse effect, like acid rain and the depletion of the Earth's ozone layer, is an atmospheric phenomenon caused by humans, which will affect human societies in the future. To understand the greenhouse effect, you must know something about how the atmosphere functions.

A planet's temperature mainly depends on three factors:

- the amount of sunlight it receives
- the amount of sunlight it reflects
- the extent to which its atmosphere retains heat

So, a distant, shiny, airless planet will be colder than a darker, humid, pea-soup-skied one closer to the sun. It all depends on the balance of light in, light reflected and light absorbed. The Earth, as we know, is beautifully situated between cold, thin-aired Mars and hot, steamy Venus.

There is More to Sunlight Than Meets the Eye

Sunlight is a tricky term; it's much more than what you see. Solar radiation includes the white light, and all the colours of the rainbow, from red right through to violet: but that's just the visible spectrum.

There's also infrared light - the sort you feel when you stand beside a pot-belly stove; and there's ultraviolet light, which is also out of the range of human eyesight. Ultraviolet rays give you a tan and cause skin cancer as proof of their existence. Along with radio waves, cosmic rays and others, ultraviolet, visible and infrared light are part of the spectrum of electromagnetic radiation.

A group of gases in the atmosphere - water vapour, carbon dioxide, methane, nitrous oxide, ozone and, recently, chlorofluorocarbons - are able to absorb radiation in the band of infrared wavelengths. They're called 'greenhouse gases' because they act a bit like the walls of a greenhouse, by trapping and retaining infrared or 'hot-body' radiation. It works like this: sunlight passes through the atmosphere (most greenhouse gases are transparent to visible and ultraviolet light), reaches the Earth's surface and heats it. Being hot, it emits some infrared radiation back into space. Some of this is absorbed by the greenhouse gases and is thus retained in the Earth's atmosphere. The air warms up, a new ground-air equilibrium is achieved and the temperature of the Earth rises.

That's how it's been since the Earth began.

The problem is not that the greenhouse effect exists - in fact we'd be much colder without it - it is that human activity since the Industrial Revolution has steadily added greenhouse gases to the atmosphere, causing heat to be trapped that would otherwise be lost to space.

As population increases we consume more energy and require more food; these activities increase the production of greenhouse gases. For example:

- Carbon dioxide (CO_2) is increasing at about 0.4 per cent per year, due to the burning of fossil fuels - oil products, coal and gas. It contributes about half the total warming effect.
- Methane (CH_4) is produced from ruminant animals, rice paddies, industrial activities involving the use of natural gas, burning wood, coal etc., and is increasing at the rate of 1 % every year.
- Chlorofluorocarbons (CFCs) are used as refrigerants, solvents, propellants for spray cans. They are long-lived, artificially produced substances that are increasing in the atmosphere at the rate of 5-7 % per year.

The total concentration of greenhouse gases will be double the preindustrial level by about the year 2030 and will still be growing!.

Compared with the amount of CO_2, and other trace gases, generated by industry, the impact of deforestation on CO_2 levels in the atmosphere appears to be insignificant. Nevertheless, retention and regrowth of native vegetation, and extensive replanting and tree-cropping as proposed by CALM on much cleared farm land, will have some value, in reducing greenhouse effects. Such steps are, of course, of great benefit for many other reasons.

How Will Our Climate Change?

The effects on the climate of any particular part of the Earth are influenced by global climatic patterns, by the lag-time in the warming of the oceans, and by regional factors, and are not easy to predict. Some of the projected changes by 2030, however, are:

- A rise in Australia's mean temperature of between 1.5°C and 4.5°C.
- Globally, tropical and sub-tropical areas are expected to become wetter, and mid-latitudes to become dryer. In W.A., summer rainfall may increase and move further south, and the zone of reliable winter rainfall may also move southwards. Thus, while much of W.A. may receive up to 50% more rainfall, it is suggested that the South West region, including most of the wheatbelt, will become dryer due to a decrease of 20% or more in winter rainfall.
- There may be large regional changes in soil moisture, runoff and water supplies. For example, a reduction of 20% in rainfall in the South West of Australia would probably lower the

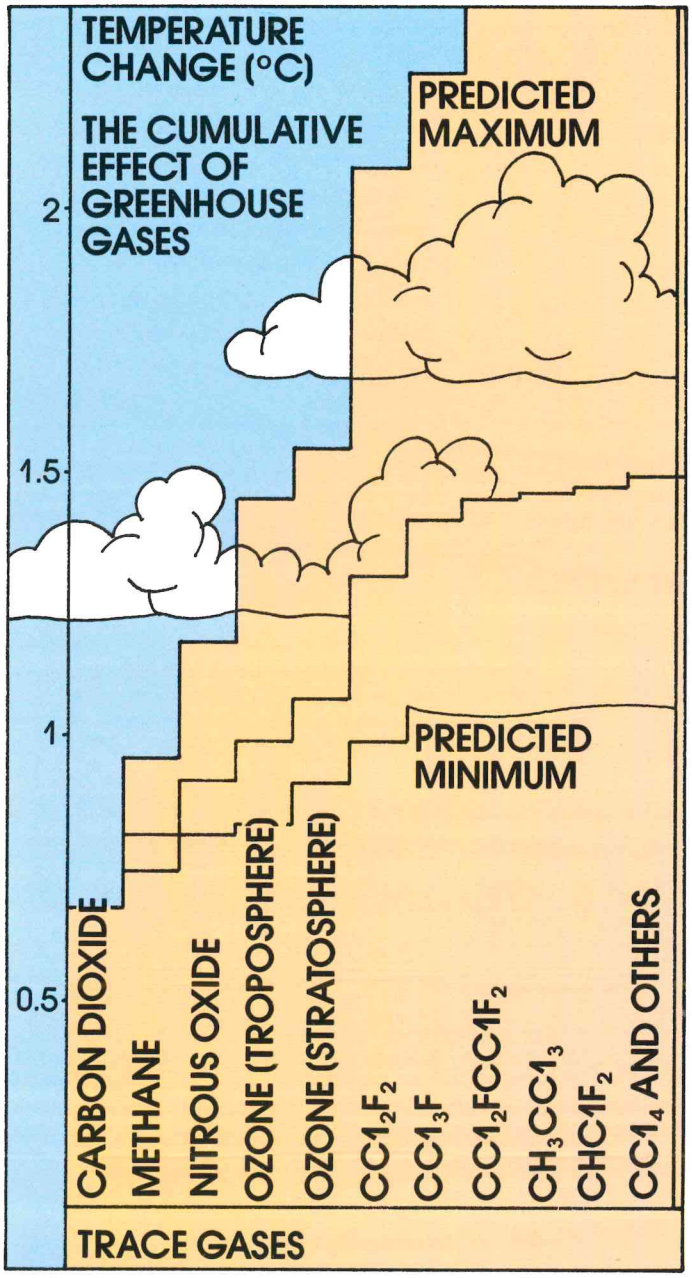
groundwater tables (such as the Gnangara Mound) by 20 m.

- Tropical cyclones may move further south and could become more frequent and more intense.
- Extreme weather patterns, such as floods and droughts, may become more frequent.
- Increased rainfall in inland areas could exacerbate salinity problems.
- Trips to eastern Australia for skiing enthusiasts may become a thing of the past, as snowfields are predicted to recede by as much as 75%.
- Increased levels of carbon dioxide have the potential to increase plant growth quite substantially.

Other possible effects include a change in sea level. Water is at its maximum density at 4°C. Above and below this temperature it expands. That's why ice floats - it's less dense than water. So if the oceans get warmer, the sea level will rise. On current projections, a swelling of the oceans will lead to sea level rises of around a metre over the next 30-50 years.

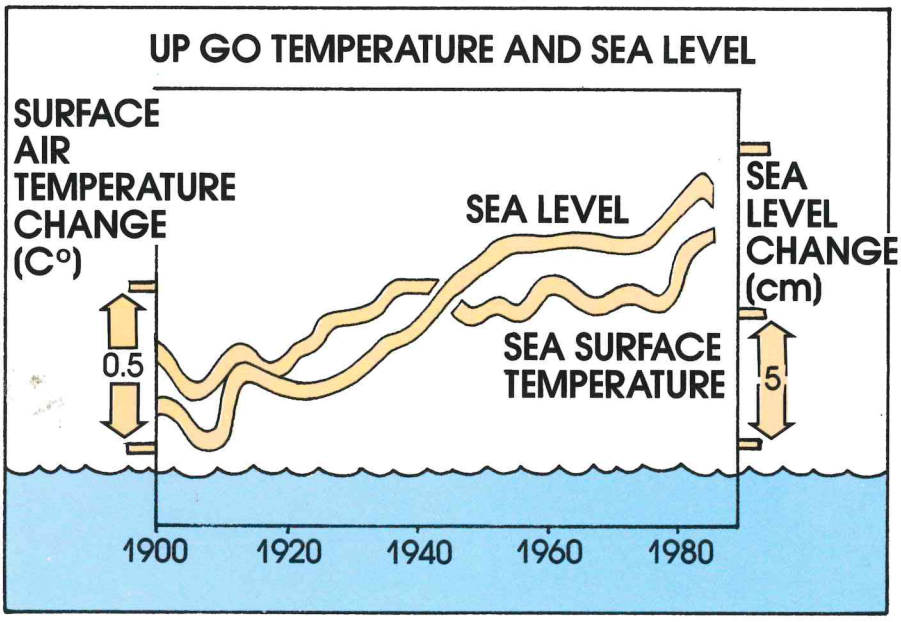
As well as the oceans swelling, melting of the polar ice caps would also raise sea levels. This is not likely to be significant for at least another hundred years, but when it does occur the reflection factor in determining a planet's temperature will come into play. With large expanses of highly-reflective ice removed, the Earth won't reflect solar radiation as well as it does now; that is, it will absorb more heat, leading to a further rise in temperature.

So, minor temperature changes can produce quite major changes to where we live. For example, during the Ice Age of about 150 000 years ago, global temperatures were



Gases other than CO_2 are now expected to contribute at least 50% of the predicted warming of the Earth by the year 2030 (Above).

As the oceans warm up, their waters expand, and sea levels rise (Below).



about five degrees lower than they are today. Correspondingly, sea levels were over 100 m lower. By contrast, during the last interglacial period, 100 000 years ago, it was one or two degrees warmer than today, and sea levels were five to seven metres higher. On current projections, by the early 21st century, average global temperature should be higher than it has been in the past 120 000 years.

The Scenario for W.A.

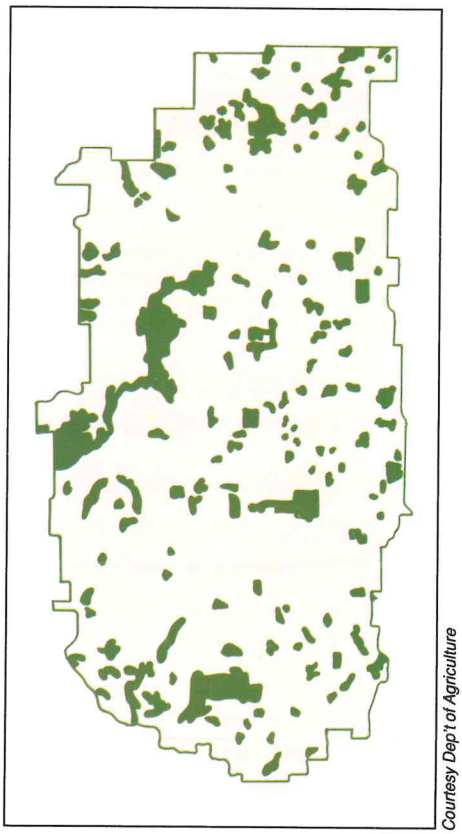
The possible effects over the next 50 years can be summarised as follows:

- for the South West, average temperatures up to 4°C higher, winter rainfall down by 20% or more and runoff down by up to 45%
- large areas on the northern fringe of the wheatbelt and throughout the pastoral zone becoming wetter and more productive
- sea levels from 20 cm to 140 cm higher, with resulting impacts upon human activities and coastal environments largely depending on the extent and severity of any increase in storms and cyclones.

Some implications for conservation and land management in W.A. are:

Nature Conservation

Wetlands would be affected in a variety of ways, depending on type and geographical position. Those wetlands dependent directly or indirectly on rainfall would be expected to expand in both size and period of inundation in the north and inland areas, and shrink and become less permanent in the South West. Most freshwater wetlands on the Swan Coastal Plain could disappear, becoming little more than occasionally wet damplands.



Courtesy Dep't of Agriculture

Isolated patches of native vegetation in the Tammin Shire. This is typical of the Wheatbelt (Above).

Isolated reserves - the greenhouse effects, if and when they occur in the South West, will be acting upon natural vegetation and biological communities already modified by human activities. The reserve system has been established on the basis of a more or less stable climate, and in many cases refugia may no longer be available, even for the more mobile species. For many sedentary species of plants and animals now 'marooned' on reserves surrounded by cleared farmlands, adaptation to, or migration away from the changing conditions will not be possible.

Some of W.A.'s most precious conservation resources are confined to offshore islands.
Many of these are low-lying and extremely important for turtles' and sea birds' nests. A rise in sea level of one metre or more would result in the almost total loss of the Abrolhos and similar low islands, while any additional frequency or intensity of cyclones or other storms could create storm surges capable of threatening even larger islands and the fauna dependent on them.

Are We Seeing Greenhouse Effects Already?

The factors determining global and regional climates and sea-levels are so complex that proving a causal link between greenhouse gases and any observed changes is extremely difficult.

A number of well-recorded changes over the last 100 years, are however, consistent with those being predicted, on the basis of physical principles and computer modelling, to result from the greenhouse effect:

average air temperatures at the Earth's surface have risen by about 0.5°C;

the warming of the Earth over the last 100 years has been accompanied by an average rise in sea-level of about 10 cm, and an overall melting and shrinkage of glaciers;

a 10-20% reduction in winter rainfall in the south west of W.A. for the period 1946 to 1978, compared with that for 1913 to 1945, is consistent with the prediction that rain-bearing winter fronts will reach and cross the coast into south-west W.A. less frequently;

comparison of rainfall data for central N.S.W. for the same two periods also shows that an increase in summer rainfall has occurred, which is consistent with a predicted move southward of monsoonal influence on Australia's east coast.

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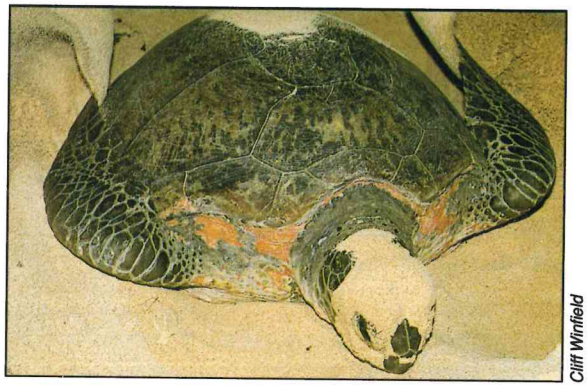
Many low, sandy or coral islands in the north of W.A. would be inundated by a sea level rise of one metre or more (Above).

The loss of low-lying beaches and islands would put at risk the breeding of many sea birds and turtles (Right).

Coastal wetlands like Lake Joondalup may virtually disappear if Perth's rainfall decreases by 20 % or more (Below).



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Jiri Lochman

Timber production

Laboratory studies indicate that a doubling of carbon dioxide concentrations (expected by the year 2030) is capable, under conditions of adequate moisture and nutrients, of increasing the growth rate of *Pinus radiata* by 40%.
The same kind of response may also be expected in species of eucalypts. With the right selection of genetic stocks and careful management of supplies of nutrients and water, the opportunity may exist for a considerable increase in the productivity of plantation forests in W.A.

Conversely, the projected drying of the South West, which would result from a combination of decreased rainfall and increased temperature, could have considerable implications for the growth of commercial timber species. Projections of yield based on an unchanged climate may need to be reviewed, and the selection or encouragement of particular species may need to be matched to altered climatic conditions.

Fire Management

Calculations suggest that a combination of decreased rainfall and increased heat for the forested regions of the South West would greatly increase the danger and intensity of wildfires. The simplified model used indicates that under these conditions, average fire danger during each summer would be at extreme levels, previously only expected to occur once in 50 years.

What Should Be Done?

We might argue that the obvious solution is to stop the generation of greenhouse gases, but it is not that simple.

The production of greenhouse gases has the whole momentum of the global economy behind it.

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'If we live as if it matters and it doesn't matter, it doesn't matter; if we live as if it doesn't matter and it matters, it matters'.

While some agreement may be possible limiting the use of some of the trace gases (e.g. chlorofluorocarbons), it seems highly unlikely that significant reductions in the global use of fossil fuels and the consequent production of carbon dioxide (currently growing at the rate of 0.4% per year) can be achieved within the next 100 years or so. Greenhouse effects, almost certainly in train now, will continue to increase for the foreseeable future.

Thus, whatever steps are taken between nations to limit the continuing increase of greenhouse gases, changes will still occur, and adaptation to them will be necessary at National, State and Regional levels.

Both nationally and internationally there will be advantages and disadvantages, and winners and losers, from the postulated changes.

For Australia, there are three critical requirements for a smooth transition to a warmer world: more precise information on what changes in climate and sea level are likely in different parts of Australia; a reliable inventory of natural and cultural resources, and how they are likely to be affected by the predicted changes; and, above all, a willingness to incorporate predictions into medium and long-term planning.

In most cases the planning and management required to anticipate greenhouse effects is simply 'good housekeeping'. If the predicted changes do not occur, little will be lost by planning on the assumption that they will. Conversely, if the changes do occur, and pre-emptive planning has not been instituted, the costs and lost opportunities could be enormous.

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The growth of *Pinus radiata* in the South-West may benefit from increased CO_2, but only if rainfall does not decrease. (Left).

Intense wild fires may become more frequent in a warmer (and perhaps windier) W.A. (Above).

In the words of the Greenhouse 87 poster - 'If we live as if it matters and it doesn't matter, it doesn't matter; if we live as if it doesn't matter and it matters, it matters'.

The Greenhouse Project

In October 1985, an international conference of scientists gathered at Villach, Austria, to assess the current status of knowledge concerning climatic change. They came to a unanimous conclusion:

> *The understanding of the greenhouse question is sufficiently developed that scientists and policy-makers should begin an active collaboration to explore the effectiveness of alternative policies and adjustments.*

That sentence sums up the thinking behind 'The Greenhouse Project: Planning for Climatic Change'. This joint initiative of the CSIRO and the Commission for the Future is the start of a campaign to alert the Australian community about the need for some very serious planning for social and economic impacts across a wide range of industries, public services and government departments.

Active collaboration requires a common understanding of the problem and of the ways of addressing it. It's easier said than done, of course: whereas scientists study the natural world in order to understand and explain its workings, policy-makers make decisions about money, time and priorities based on what people see as important issues of the day: less taxes, more leisure, a nicer place to live and so on. They seem to be worlds apart. The task of the Greenhouse Project will be to bring them together, partly by helping with some basic science, partly by forging new networks for people with a common interest.

Is Ozone Depletion Related To The Greenhouse Effect?

Ozone, a rare form of oxygen with three atoms per molecule instead of the normal two, is produced by the action of ultraviolet light on 'normal oxygen' and by lightning. In the atmosphere it forms a 'shell' of greatest concentration at an altitude of about 25 km, and has the capacity to trap incoming ultraviolet light, so reducing the intensity of this often harmful wavelength reaching the earth's surface.

Chlorofluorocarbons, only produced since the 1930s', and the most rapidly growing of the greenhouse gases, are better known for their capacity to combine chemically with ozone in the Earth's atmosphere, therefore reducing atmospheric protection against incoming ultraviolet radiation.

Although both the ozone itself, and the chlorofluorocarbons are greenhouse gases, that is, capable of absorbing infrared radiation, there is no other link between ozone depletion and the greenhouse effect. The loss of ozone as a greenhouse gas is more than made up for in terms of the greenhouse effect by the increase of chlorofluorocarbons. There is no 'balancing out' between the two processes.

The significance of the ozone depletion relates to adverse effects on human health and (possibly) plant-growth stemming from increased levels of ultraviolet light reaching the earth.

There is little evidence yet to suggest that the observed seasonal 'holes' in the ozone layer over Antarctica are spreading over more inhabited parts of the Earth.

In any case, a reduction in the use of chlorofluorocarbons, recommended by the recent Ottawa agreement to slow down the depletion of ozone, will also help reduce the growth of greenhouse gases.

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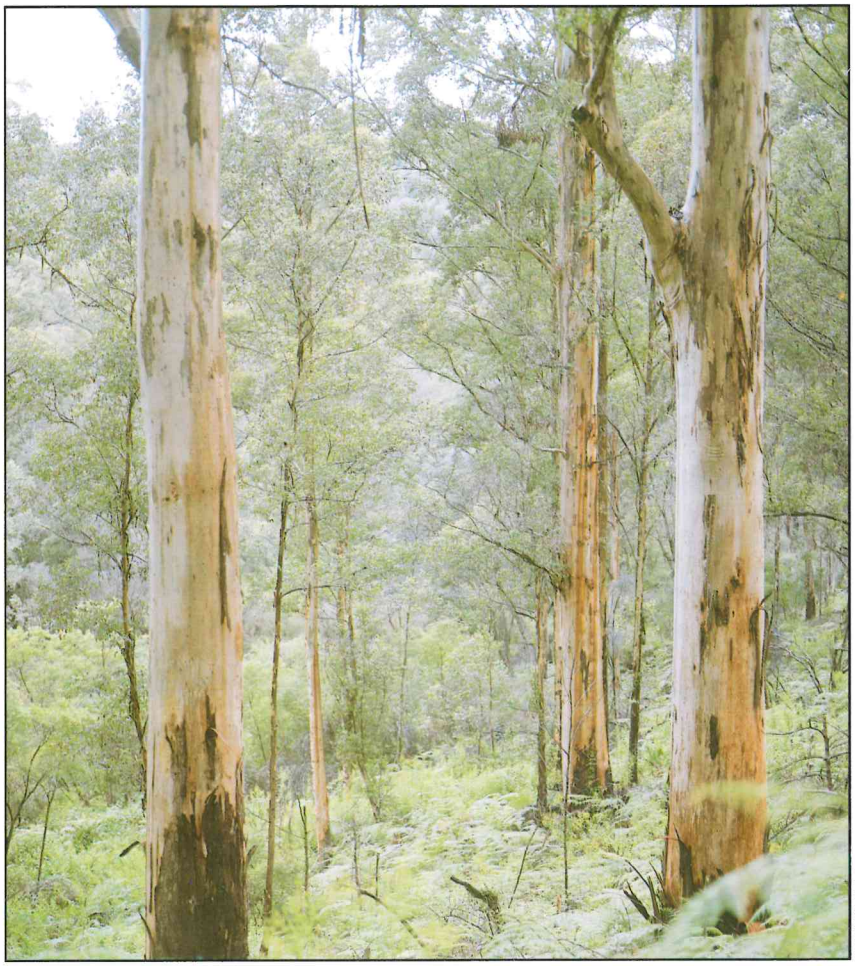
Reduced rainfall and runoff is likely to reduce populations of water birds, such as Black Duck, in the South West (Left).

Changes to rainfall patterns in W.A. may be critical for the distribution and timber yield of karri forests (Below).



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Greenhouse Project Activities

A National Workshop formally launched the project on 16 September 1987. In this workshop, scientists worked with industrialists, government officials, representatives from the insurance, tourism, contruction and other industries on climatic change.

Working groups commenced at the Workshop are continuing to research and gain broader industry or sectoral support.

A Greenhouse 87 conference was held in December for scientists and technologists with particular expertise in matters relating to climatic change. Considerable activity within several states has already grown from that conference.

Greenhouse 88, a pan-Australian community conference will be held late in 1988 and will be linked electronically across all capital cities and other major centres. It will be dedicated to broad public discussion of the potential social, economic and environmental impacts of the greenhouse effect rather than to specific fields of scientific study.

Working groups are being organised around the following eight categories:

- primary industry: agriculture, mining, fisheries, forestry;
- manufacturing industry: building, construction, bio-techology;
- service industries: insurance, transport, tourism, finance;
- public works and services: coastal management, public facilities;
- the water industry: sewage, irrigation, urban water management;
- Government, policy and law: local, State, federal and international regulations, conventions and laws;
- conservation and environment: governmental departments and community groups;
- education: primary, secondary, tertiary institutions, community groups.

In W.A. a multi-agency Policy Advisory Committee on Greenhouse Effects is proposed, with the following terms of reference:

- to advise agencies and government on long term policies
- to promote awareness of the issue in agencies and the public
- to promote assessment of the likely impacts
- to coordinate investigations and monitoring
- to formulate general strategies for meeting climate changes
- to liaise with national groups

For the foreseeable future, much human activity will need to be planned on the basis of a changing climate. How well that planning is conducted will largely determine how well society copes with the changes.