THE PLANET EARTH seems to have a slight fever. It cannot be discerned readily, only as a slowly-emerging pattern obscured by short-term fluctuations. But scientists now generally agree that the average temperature of the global atmosphere has been increasing for a century, and will likely continue to do so throughout the next.

While not universally accepted or understood, the trend has profound implications for life on Earth. In fact, some conservationists, prompted by Robert L. Peters II, a biologist with the World Wildlife Fund in Washington, D.C., warn that the warming could contribute to mass extinctions of plant and animal life, possibly in our lifetimes.

The apparent cause of this temperature increase is human activity. In spreading across the globe, humans and their increasingly complex technology have continuously spewed various substances into their environment. One of these, not much noticed until recent years, has been a largely innocent gas called carbon dioxide, generated by a number of natural life processes, and in recent times, by the burning of fossil fuels. During the last century, most climatologists now agree, a man-made buildup of carbon dioxide and other gases (methane and chlorofluorocarbons in particular) has increased the amount of solar heat retained in the lower atmosphere—a process that has come to be known as the greenhouse effect.

For a number of years, experts have been discussing what might happen if the fever continues, as expected, to climb. Thermal expansion of the oceans and the melting of glaciers could cause sea levels to rise five feet during the next century, inundating coastal wetlands and developments. If substantial heating were to continue, partial melting of the south polar ice cap could eventually flood entire cities. Altered rainfall patterns, an inevitable consequence of the temperature changes, could make much of the North American grain belt too dry for normal agriculture while other regions luxuriate under unaccustomed heat and deluges.

What has not been discussed, until very recently, is the question of what these changes will do to wild plants and animals, particularly those already threatened with extinction. But Peters has noticed two new factors in the greenhouse equation that may have serious and far-reaching consequences for ecosystems and wildlife. For one thing, he says, this climate change will be much faster than past warmings or coolings of the Earth, outracing the ability of many species to adapt. For another, the changes will find thousands of species blocked by farm fences and fields, four-lane highways, housing developments and other man-made barriers as they try to escape to cool safety near the poles or at higher altitudes. The very refuges and parks now set aside to preserve wildlife may prove to be deadly traps.

The combined effects of these influences may mean mass extinctions within the next hundred years, especially since they are happening during a time when species are already at unprecedented risk. "There is reason to believe," says Peters, "that the impact on the natural world could rival that of the last Ice Age."

The diagnosis of the fever—that the world's average temperature has increased less than a degree Fahrenheit during the past century—seems at first glance an underwhelming statistic. But the current prognosis is that the average temperature (now 59 degrees F) will continue to climb between three and eight more degrees during the next century, possibly the next 50 years. This would make the Earth warmer than at any time in the last 100,000 years.

How much harm could result from a change of a few degrees? Consider what happened in the American South during the summer of 1986—

WILL SPECIES DIE OUT AS THE EARTH HEATS UP?

Our planet is warming because of human activity, and that may contribute to mass extinctions in our lifetimes

By Thomas A. Lewis
Illustrations by Rob Wood

a single season of higher-than-average temperatures and lower-than-normal rainfall. The wood duck population plummeted when hatchlings emerged from their nests to find themselves on dry ground, vulnerable to their predators, instead of safely afloat. Many quail eggs did not hatch at all because of the heat and drought. Alligator nests, ordinarily inaccessible in their boggy swamps, were ravaged by raccoons and bears taking advantage of the firmer ground. Immature acorns began dropping three months earlier than usual, thus greatly reducing the all-important winter food supply for much of the area's wildlife.

Such short-term heat waves and droughts are common events, of course; even drastic, long-lived changes in climate have occurred many times before. During the billion years that life has been on the land, much of the Earth has been a hot place. Only during seven ice eras, each millions of years in length, has the climate cooled to levels familiar to humans. Each of these periods was apparently studded with dozens of ice ages, followed by milder periods called interglacials.

Trees and grasses and shrubs and animals were able to shift away from the advancing cold, then back again with the returning warmth, since the changes were relatively slow, taking place over hundreds, perhaps thousands of years. During a warming trend, individuals in the hotter extremes of their range generally faced the biggest difficulties while those in more temperate regions survived, often moving into new territory. This dispersal was facilitated on the American continents by the absence of such barriers as east-west mountain ranges. Peters points out that during previous interglacials, "Osage oranges grew near Toronto, manatees swam in New Jersey, wild pigs foraged in Pennsylvania and Cape Cod had a forest like that of present-day North Carolina."

Even at that glacial pace, however, many species lost the race for survival, either because they could not move fast enough or because something prevented them from moving far enough. In Europe, the advancing glaciers trapped many species between the unstoppable surges of cold and such immovable barriers as the Pyrenees, the Alps or the Mediterranean. The sweet gum, tulip poplar, magnolia and hemlock trees,

A "Greenhouse Effect" Changes Our Climate

Burning fossil fuels such as coal and oil increases the amount of carbon dioxide in the atmosphere. The CO_2, along with other gases released by human activity, forms an invisible barrier in the sky, not unlike the roof of a greenhouse. Incoming radiation from the sun can pass through, but heat re-radiating from the Earth is trapped. The result may be global warming.

Why Man-Made Warming May Cause Extinctions

When the Earth's climate warms, rainfall patterns change. This modifies habitat for tens of thousands of species. In prehistoric times, most plants and animals had time to move to more hospitable areas. But man-caused warming may occur too quickly for some species to disperse. Man-made barriers such as farms and cities will block escape routes of others. The result could be extinction for many species.

Prehistoric times: species disperse

OVER THE COURSE of geologic time, the Earth's climate has alternately warmed and cooled. With each climatic shift, habitats have changed, forcing plants and animals to move to new areas or die out. In one typical warming, a forested region (top panel) becomes desert (bottom panel). But since the change usually occurs over centuries or even millenia, most species are able to adapt, dispersing slowly to more temperate regions (arrow). The only barriers blocking their odyssey to more suitable habitat are natural features such as mountains and oceans. Although some plants and animals do disappear, most survive, bypassing these natural impediments to movement.

The near future: species die out

IN MODERN TIMES, when man-made climate shifts are measured in decades, many plants and animals survive only in wildlife reserves or parks—small islands in a sea of farms and cities (top panel). When the climate begins to warm (bottom panel), the change is so rapid that many species simply do not have time to disperse. Others (arrow) are blocked by the new man-made barriers and die out. In this scenario, reserves and parks become empty shells, and large numbers of plants and animals go extinct. For conservation planners, one answer may be to modify reserves now and build corridors for escape.

Wildlife reserve

ROB WOOD (STANSBURY, RONSAVILLE, WOOD INC)

once plentiful in Europe, were squeezed out of existence there while they survived in the open spaces of North America.

This time, says Peters, if the greenhouse effect is working as expected, the warmup will occur within a few decades. In the Northern Hemisphere the areas where present vegetation can live will shift long distances, perhaps 200 miles northward, during the next century, he says. This seems a leisurely pace until one compares it with the average speed with which vegetation can move; dispersal rates for many North American tree species are under 25 miles per century.

But even if we were to lose some trees—a forest here, a swamp there—surely wild animals would simply move on to better habitat, as they have done during previous ice ages and interglacials? Probably so, if this were a previous ice age or interglacial. But today's species are faced by that endless array of human barriers. A city is as effective as a mountain range in preventing the propagation of a forest.

In 1982, for instance, when drought struck Botswana's Kalahari Desert, a quarter of a million thirsty wildebeest migrated north to traditional watering points. Many never made it. Some 80,000 were funneled into one small area of range. Blocking their route to water was a 100-mile-long fence built to protect cattle from disease. Scores of the antelopes died.

Just as in the Botswana drought, the refuges that constitute humankind's principal effort to preserve the world's biological diversity—parks, national forests, wildlife sanctuaries, wilderness areas and the like—may well prove to be traps should a rapid climate change take place. In the 200-mile shift of habitat envisioned, no parks will be large enough to provide scope for the dispersal required. Because their habitat abruptly ends, countless plant and animal species could be caught against the boundaries of these reserves and extinguished there.

The threat would seem to be much less for such mobile and abundant animals as deer, which are physically capable of moving to new areas. But Peters points out that some deer species are wedded to certain combinations of cover and browse, and by habit move surprisingly short distances in their lifetimes—just a mile or two per year. They may be unwilling or unable to move away from familiar habitat even if it is drought-stricken.

The implications of the Peters scenario for the management of national parks and reserves designed to protect wildlife and plants are staggering. "Conservationists have tended to assume a constant climate," he writes, "as though, once we have preserved a piece of a community from the immediate threats of development, we have saved it in perpetuity. Now we know this is not so."

The preservation of existing species during a drastic climate change in the Northern Hemisphere, he says, might require such measures as dramatic northward expansion of present reserves; heroic efforts to maintain the suitability of existing reserves by artificial means, such as irrigation; or the physical transportation and introduction of species to other reserves. Even if technically possible, notes Peters, such efforts will be "costly and perpetual."

While it is too early to expect any country to undertake such astronomically expensive measures, it is also too late to ignore the possible consequences of taking no action at all. "We need more knowledge," says Peters. "We must refine our ability to predict future conditions in reserves. We also need to know more about how temperature, precipitation, carbon dioxide concentrations and interspecific interactions determine range limits."

There are signs of a growing consensus in the scientific community that the need for such research is urgent. When Peters proposed a symposium on the possibility of mass extinctions because of the greenhouse effect, he received support from such U.S. organizations as the Environmental Protection Agency and the Smithsonian Institution. The gathering is scheduled for the spring of 1988.

In the meantime, Peters is campaigning for increased awareness of the potential danger, and for some appropriate interim measures. Although not many new parks and refuges are being created these days, he recommends that special attention be paid to preserving, expanding and creating reserves that are topographically diverse. Species can much more easily shift a short distance up a mountain than a long distance cross-country; a 1,600-foot increase in altitude is roughly equivalent, in terms of climate change, to a 200-mile trip toward the poles. Overall, he says, the appropriate rule of thumb for a changing Earth is: "Don't put your reserves where your species won't be."

For the moment, despite the slight fever, the patient remains vigorous and generally healthy. But more and more experts are watching the various temperature readings and test results with furrowed brows. More tests are being requested, more information sought, and there is an increasing sense of urgency as the fever continues to climb. ▣

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