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All creatures great and small



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Biodiversity, once the preoccupation of scientists and greens, has become a mainstream concern. Liberal helpings of growth and technology are the best way of preserving it, says Emma Duncan

IF THE EVENTS of a single night can be said to have shaped the fate of life on Earth, it could be those that took place in Paragominas on November 23rd 2008. Paragominas is a municipality in the Brazilian Amazon two-thirds the size of Belgium. Its population of 100,000 is made up largely of migrants from the south of the country who were encouraged by the government to colonise the area and chop down the forest. The small town that is its capital has an air of the wild west about it. Men wear cowboy hats in the streets. Five years ago it was a rough place, its air full of sawdust and rumours that slave labour was used in the charcoal business fuelled by Amazonian timber.

Earlier that day, at the request of the mayor, Adnan Demachki, the federal environmental police had confiscated some lorries piled high with illegally cut logs (pictured). The loggers were not happy. That night a few hundred of them entered the town, repossessed some of the trucks, set them and the office of the environmental police on fire and then tried to burn down the mayor's office too. Paragominas was known to be the front line of the fight against deforestation, so the burning trucks were all over the nation's television screens.

Mr Demachki, elected for his efficiency, not his political views, had come to believe that Paragominas was on the wrong side of history. He called a town meeting and held up two letters he had written. One apologised to the nation for the previous

day's events and committed Paragominas to stopping deforestation. The other announced his resignation. The townsfolk chose the first. The mayor stayed in his job, and Paragominas changed its ways.

The events in Paragominas have been repeated, in less dramatic ways, across much of the Brazilian Amazon. Deforestation has fallen steadily, from 28,000 sq km in 2004 to 5,000 in 2012. Whether this is a permanent victory or a temporary respite is not yet clear, but the fact that Brazil has succeeded in greatly reducing a seemingly unstoppable process of destruction raises hopes for the future of the rest of life on Earth.

The change has been a long time coming. Ever since man first picked up a spear, other species have suffered. Man wiped out most of the mega-fauna—the mammoths, the sabre-toothed tigers, the mastodons, the aurochs—that roamed the planet before he did. When he sailed the Pacific, he killed off half the bird species on its islands. As his technology improved, so his destructive power increased. When he learned how to exploit the Earth's minerals and hydrocarbons, he started to multiply ever faster, leaving ever less room for the planet's other species. He chopped down forests, poisoned rivers and killed large numbers of the biggest sea fish and marine mammals. Many believe that, as a result, a mass extinction comparable to those of prehistoric times may be under way.



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The cover photograph of Yao Ming, a basketball player, was taken by Kristian Schmidt for WildAid at the David Sheldrick Wildlife Trust in Kenya, which saves orphaned elephants.

A list of sources is at Economist.com/specialreports
An audio interview with the author is at Economist.com/audiovideo/specialreports



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Squeezed by Homo sapiens

► In a sense, this orgy of destruction was natural. In the wild, different species compete for resources, and man proved a highly successful competitor. Religion sanctioned his ascendancy. The Bible granted mankind “dominion...over every creeping thing that creepeth over the earth”. If he stamped on a few of them, so be it.

But in recent times attitudes have changed. People have, by and large, come round to the view that wiping out other species is wrong. Part of the reason is pragmatic: as man has come to understand ecology better, he has realised that environmental destruction in pursuit of growth may be self-defeating. Rivers need to be healthy to provide people with clean water and fish; natural beauty fosters tourism; genes from other species provide the raw material for many drugs. But man also finds it troubling to think that as the only species able to marvel at the diversity of creation, he should be responsible for killing it off.

Putting Humpty back together again

The change in attitudes has had political consequences. In recent decades, first in the rich world and then increasingly elsewhere, laws to ban the killing of and trade in endangered creatures and to protect areas rich in biodiversity have been enacted. Governments are buying up important natural sites, restoring damaged ecosystems, setting up captive breeding programmes for critically endangered species and so on. Green NGOs and concerned individuals have also been helpful.

Endangered species have benefited from some of the concomitants of growth, too. Improved sanitation has made the planet healthier, as has regulation of pesticides. Cleaner air is better for biodiversity. As countries get richer, they tend to become more peaceful and better governed and their population growth slows down. Technological progress has improved life for other species, making conservation efforts more effective.

Although these successes can in part be credited to the environmentalist movement, greens tend not to boast of them for fear of damaging their cause. By walking the planet with a sandwich-board predicting impending doom, they have helped reduce the chances of an ecological calamity. If people believe catastrophe has receded, they may stop making an effort to avert it.

And they are right that the future for many species is by no means assured. Although things are improving in most of the rich world, in most of the emerging world—which is where the greatest number of species live—they are still deteriorating. Mass extinction remains a real danger.

Whether or not it actually comes about depends in part on what happens to the climate, which remains the subject of much guesswork. This newspaper has written about climate at length and this special report will not go over that ground again, except to say that if warming turns out to be at the upper end of the scale envisaged by the International Panel on Climate Change, the consequences for biodiversity—as well as for people—will be calamitous. If it remains at the lower end of the scale—as slower temperature increases over the past decade suggest it may—then most species will not be adversely affected.

Instead, this special report will focus on the relationship between humanity and the rest of the planet’s species in recent years. It will argue that thanks to a combination of environmental activism and economic growth the outlook for other species has improved, and that if growth continues, governments do more to regulate it and greens embrace technological progress, there is a decent chance of man undoing the damage he has done during his short and bloody stay on the planet. ■

Extinction

Dead as the moa

Extinction is a fact of life, but rates seem to be slowing down

IN THE LATE 1830s a young man called Richard Owen was the assistant curator at the Hunterian Collection of the Royal College of Surgeons in London. Owen, later the prime mover in establishing the Natural History Museum, was making a name for himself as an anatomist of strange creatures. It was a rich time for exploration and travel, so people brought him all manner of exotica: his wife once came home to find the carcass of a rhinoceros in the hall.

Another such curiosity was a piece of bone from New Zealand’s North Island. Owen realised that the bone’s honeycomb structure, built for lightness, was typical of a bird, but the bird it belonged to would have had to be far larger than any known creature. He was widely ridiculed for his conclusion, but other bits of evidence that there had been odd wildlife in New Zealand ►►

► not all that long ago were piling up. Middens of enormous bones were discovered, some so large that their contents were ground up and used as fertiliser.

The bird that Owen had identified was the moa (pictured with him below), a sort of supersized ostrich. But that was not the only creature that had disappeared. Since the Maori's ancestors arrived in canoes from Polynesian islands in 1250-1300, New Zealand has lost 51 species of birds, three of frogs, three of lizards and one of a freshwater fish. Their demise was brought about by a combination of hunting, deforestation and the Polynesian rats that the Maori brought with them.

The moa bone was the first piece of evidence of one of the most recent megafauna extinctions. Not very long ago huge beasts roamed every continent. In North America there were giant sloths, a lion, short-faced bears, mammoths, mastodons, a sabre-toothed salmon and much more; in Europe and Asia there were woolly mammoths, aurochs, lions and several sorts of rhinoceros. Australia once boasted an eight-foot-long horned turtle and a 25-foot lizard. "We live in a zoologically impoverished world from which all the hugest, and fiercest, and strangest forms have recently disappeared," wrote Alfred Russel Wallace, the man who cracked evolution at the same time as Darwin.

There were clues to the reasons for their disappearance. Joel Polack, an author who travelled in New Zealand in the 1830s, wrote that "the natives claim to have received tradition that very large birds had existed, but the scarcity of animal food, as well as the easy method of entrapping them, had caused their extermination." Owen speculated that man was probably to blame, but it was not until a century later that Paul Martin, a scientist at the University of Arizona, developed the theory of "Pleistocene overkill", which held that as man spread out from Africa and colonised new continents, he killed off the great beasts he found there. The fact that large and often vulnerable creatures that would make a decent lunch suffered disproportionately points the finger at man.

The dates work. Man arrived in Australia 48,000-50,000 years ago; the megafauna died out 46,000 years ago. Big animals lived on in Tasmania until a land bridge with Australia formed 43,000 years ago, allowing people to cross into Tasmania, and were gone 41,000 years ago. In North America the megafauna seems to have disappeared around 13,000 years ago, around the date of the first human settlements.

In Europe and Asia the extinctions were fewer and less sudden. That, goes the theory, is because close relations of man arrived there much earlier than in Australia or North America, so the megafauna learned to live with people. In Africa, the continent where man was born, nature had even longer to work out how to rub along with the aggressive two-legged ape, which is why the continent retains many of its ancient great beasts. Some palaeontologists still prefer a climatic explanation for this new bout of extinctions, but most reckon that man was either

partly or wholly responsible.

In the grand scheme of things this wave of destruction was not particularly remarkable. Throughout Earth's history extinction has been the norm. Around 99% of all creatures that have ever lived have disappeared from the face of the planet. Hardly any of the species that are around now existed 100m years ago; it is unlikely that many of today's species will still exist in another 100m years. In the Earth's 4.5 billion-year history, that is not a very long time.

Extinctions come about in great waves, of which there have been five through history. The most recent, at the end of the Cretaceous era, happened around 66m years ago and killed off perhaps 75% of species, including the dinosaurs; the biggest, at the end of the Permian, was 252m years ago and killed off 96% of species. Those extinctions are thought to have been caused by geological events and the impacts of asteroids. The big question is whether a sixth great extinction, this one caused by man, is now under way.

Counting backwards

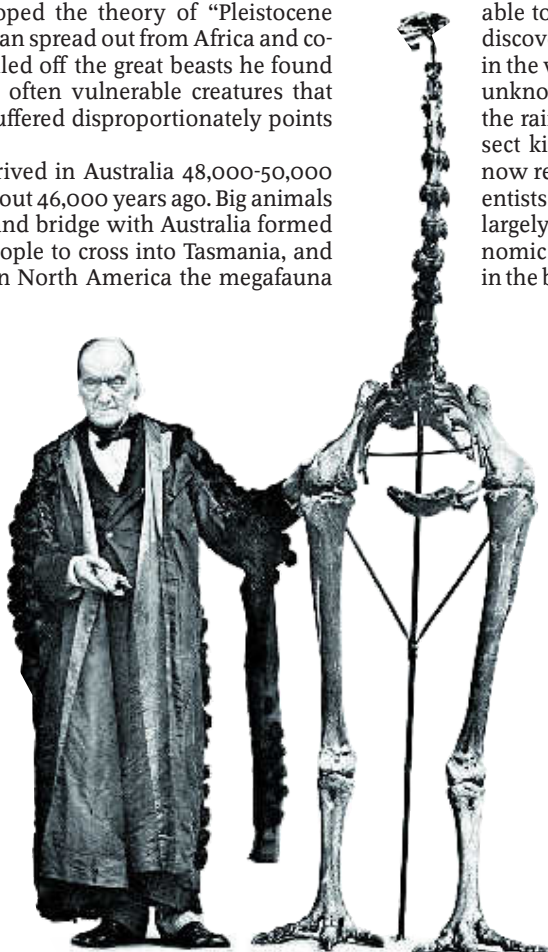
To assess the impact of humanity on biodiversity, you need to know how many species there are on the planet, and how many species have gone extinct in recent years. Neither number is known, but the guesses have got a bit better.

Start with the number of species in existence, of which around 2m have been identified. More big creatures than small ones have been described—nearly a million animals, for instance, compared with 43,000 fungi—but since there are a lot more small creatures than big ones, it seems reasonable to assume that many small species remain undiscovered. Estimates of the total number of species in the world, allowing for what may be lurking in the unknown depths of the ocean, the vast diversity of the rainforest and the nooks and crannies of the insect kingdom, have ranged up to 100m, but that is now regarded as wildly over the top. These days scientists base their guesses of the number of species largely on the rates at which groups at higher taxonomic levels (such as family and genus) and species in the better-known groups of animals (such as vertebrates) have been described, which produces considerably smaller numbers. The most widely used estimate now is 8.7m species, not counting micro-organisms such as bacteria and archaea.

Even without asteroids or man, some species would die out. Stuart Pimm, a scientist at Duke University, has calculated this "background" rate of extinction to be one per million species years—in other words, if there were a million species on the planet, one would go extinct every year and if there was one species on the planet, it would go extinct in a million years.

To try to measure the current extinction rate against the background rate, Mr Pimm looked at bird species, which—thanks to the enthusiasm of ornithologists—are better catalogued than any other creatures. There are around 10,000 of them. If the background extinction rate were the only force at work, one bird species should go extinct every century.

Most of the birds that have become extinct went the way of the moa: they were en- ►



► demic to Pacific islands that were colonised by hungry people. A combination of bones and maths—estimates of how many species there may have been on an island based on its size and geography—led Mr Pimm to conclude that the Polynesian migrants wiped out 50-90% of bird life in the islands they colonised, so around 1,000 species are missing. If those calculations are right, the Polynesians were exterminating a species or two a year, at least a hundred times the background extinction rate.

Still, that particular spate of destruction is over, so the numbers cannot be used to estimate the current extinction rate. The problem is not just knowing how many species there were and how many there are now; it is also knowing when a creature has gone extinct. Establishing an absence is more difficult than establishing a presence.

Think of a number

In the 1970s scientists started trying to estimate extinction rates based on assumptions, not observation. On the basis that tropical forests are reckoned to be home to around half the animal and plant species on Earth, and that such forests were being chopped down fast, scientists came up with massive figures. In 1979, for instance, Norman Myers, a British environmentalist, suggested that a million species might well go extinct in the last quarter of the 20th century. Such figures filtered into the political arena, too. The Global 2000 Report to the President, published in 1980 by America's Council for Environmental Quality and the state department, said that "between half a million and 2m species—15-20% of all species on Earth—could be extinct by 2000."

Nobody now thinks that anything remotely on that scale has happened. The number of birds and mammals known to have gone extinct between 1980 and 2000 is just nine, and although some species will undoubtedly have disappeared unnoticed during those two decades, it is unthinkable that a fifth of the planet's species could have been wiped out while nobody was looking. What is more, among birds and mammals at least (the classes for which data are most reliable), numbers of known extinctions have recently been falling (see chart 1).

The discussion about why and how far those early estimates were wrong has been conducted at an emotional pitch that would surprise laymen. Extinction rates have become highly political. A scientist who leans towards the lower end says that he was accused of being "anti-conservation" by another who favours higher numbers. Some scientists fear, not unreasonably, that unless people believe mass extinction is imminent, they will not bother to do anything about it.

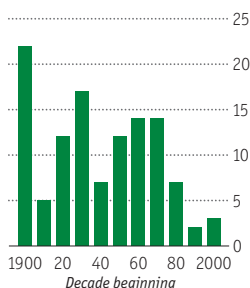
One possible reason why scientists overestimated extinction rates was put forward by Fangliang He and Stephen Hubbell

in 2011. They reckon that the models scientists were working with underestimated species' ability to survive a lot of deforestation. In Brazil's Atlantic forest, some 90% of which has been destroyed, not a single species of bird is known to have gone extinct.

But there is another explanation which gives more credit to the doomsayers. Since the 1970s humanity has made far greater efforts to protect other species, mainly thanks to a change of attitudes which the pessimists helped to bring about. ■

Fewer farewells

Global number of known bird and mammal extinctions



Sources: Birdlife; Peter Maas



Public attitudes

What's the use?

The reasons for preserving biodiversity are becoming more widely understood

WHEN COLIN WATSON grew up in a Yorkshire mining village just after the second world war, raiding birds' nests for eggs was regarded as a virtuous hobby that kept boys out of trouble and did no harm. By the time Mr Watson died in 2006—after falling from a larch tree, reaching out for a sparrowhawk's nest—the world had changed. The Royal Society for the Protection of Birds (RSPB) had confiscated his collection of 2,000 rare birds' eggs and he had been convicted six times and fined thousands of pounds.

The shift in humanity's approach to the natural world is in part the result of a long, slow evolution in moral attitudes that started long before Mr Watson's boyhood. Its origins lie in the three great intellectual movements of recent times.

The Enlightenment changed man's attitude to the rights of others. Once upon a time people were not expected to take the well-being of anybody beyond their family or tribe into consideration. Then the scope of moral responsibility widened to include compatriots and, later on, foreigners. More recently the circle expanded further to include other creatures, but only up to a point: few people think that animals are due the same consideration as human beings, though few now reckon they are due none at all. Compassion does not always sit comfortably with conservation (see box later in this article), but a broad concern for the welfare of other species underlies environmentalism.

In the 19th century the industrial revolution spawned the Romantic movement, which viewed civilisation as barbaric and nature as the source of all beauty: just as man started to destroy his surroundings, so he began to treasure them. Today's environmental movement owes much to writers such as Henry Thoreau, who contrasted the shallowness of contemporary society with the spiritual depth he found living in a cabin in the woods.

Lastly, the theory of evolution undermined the Biblical notion of man as separate from, and appointed by God to have dominion over, the rest of creation. Discovering that you are an ape ►►



► makes it harder to kill primates.

In the 20th century the spread of industrial farming fuelled environmental concerns. “Silent Spring”, a book by Rachel Carson published in 1962, about the impact on bird populations of DDT, a widely used pestkiller, helped foster a sense that society had got things upside down. Civilisation was uncivilised and economic growth was destroying, not creating, the things in life that were of real value.

A new sort of luxury

In the 20th century it was certainly true that economic growth was destroying nature at an unprecedented rate. But the prosperity that the growth created also gave people more freedom to think about things beyond their material welfare. Those well supplied with the necessities of life can use their resources on luxuries, be they handbags or bird-watching.

Prosperity also gave people more leisure, and enjoying nature is one of humanity’s most popular pastimes. Some 71m Americans say they watch, feed or photograph wildlife in their spare time, more than play computer games, and 34m are hunters or anglers who also, in their own way, enjoy wildlife.

George MacKerron and Susana Mourato from University College London and the London School of Economics recently looked at the relationship between happiness and nature. They found that people are happier in all outdoor environments (except in fog or rain) than they are indoors. What makes them happiest is taking exercise or bird-watching by the sea or on a mountain with someone they like. Those seeking to cheer themselves up should avoid bare inland areas, suburbia and children.

The second reason why humanity has started paying more attention to nature has nothing to do with fun or morality. It is that as people have messed up bits of the environment, they have come to understand the complexity of ecosystems as well as their importance for human welfare.

Two of the sharpest illustrations of this come from China’s Great Leap Forward. In 1958 the Chinese government announced that sparrows were to be targeted as part of the “Four Pests” campaign because they ate grain, offering rewards for killing them. People obediently tore down the birds’ nests, caught them in nets and banged saucepans to stop them landing anywhere. Sparrow numbers collapsed. But the birds, it turned out, ate insects that ate crops, and their slaughter thus contributed to the great famine of 1960 that killed 20m people.

At the time China was also stepping up its timber produc-

tion, increasing the harvest from 20m cubic metres a year in the 1950s to 63m cubic metres in the 1990s. The area covered by forest shrank by more than a third over the period. The resulting soil erosion gummed up the Yangzi River. In 1998 it flooded, killing 3,600 people and doing around \$30 billion-worth of damage.

The story of Newfoundland’s cod fishery offers a similar tale of self-defeating destructiveness, this time from the capitalist world. Around 1600 English fisherman reported that the cod off Newfoundland were “so thick by the shore that we hardly have been able to row a boat through them”. Factory fishing started in the 1950s, and the catch peaked in 1968 at 810,000 tonnes. By 1992, when cod biomass was reckoned to have fallen to 1% of its level before factory fishing started, the government declared a moratorium, but the cod fishery never recovered.

The reasons for the decline in populations of pollinators such as bees are less clear. According to a United Nations report, the number of honey-producing bee colonies in America more than halved between 1950 and 2007; European populations have also dropped. Pesticides, habitat loss or the spread of disease through globalisation may be to blame—nobody is sure. Whatever the explanation, the costs are potentially huge. Wild and domesticated bees as well as other insects such as hoverflies are especially important in the production of fruit, vegetables and oilseeds. According to an estimate in 2007, the global value of pollinators to farmers is €153 billion.

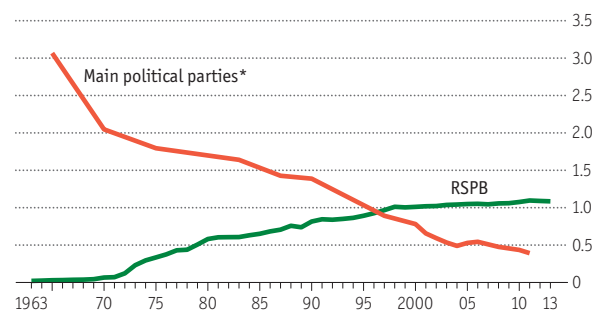
The potential of biodiversity for the pharmaceuticals industry is not easily quantified but hugely important. Around half of new drugs are derived from natural products. That should not be surprising: as Thomas Lovejoy, who holds the biodiversity chair at the Heinz Centre in Washington, points out, the genome of every living creature is a unique solution to a unique set of problems. So it seems likely that out there in the rainforest genomes exist that would be useful to humanity, if only humanity knew about them before it wiped them out.

The gastric brooding frog, for instance, appeared to scientists to hold great promise. This strange creature, endemic to Australia, gestated its offspring in its stomach. That suggested it could turn off production of stomach acids, which would be useful for people with stomach ulcers or recovering from stomach surgery. Research on the frog started in the 1980s, but the only two species of gastric brooding frog went extinct shortly afterwards. A scientist at the University of New South Wales is currently trying to resurrect the frog from surviving DNA.

But the services that other species perform for mankind do not stop there. Just as scientists are discovering that the human body is a huge colony of different species, with a large variety of bacteria inside every one of them, so they are finding out that the ►

Plumage not politics

Membership in Britain, m



Sources: House of Commons Library; RSPB

*Conservative, Labour and Liberal Democrats

Amsterdam's wild side

A Dutch experiment recreates nature red in tooth and claw

IN WINTER AND early spring commuters on the fast train between Amsterdam and Vlissingen are sometimes confronted with the sight of emaciated and dying cattle, horses and deer, and the carcasses of earlier victims being picked over by scavengers. The railway line skirts the edges of the Oostvaardersplassen, 56 square kilometres of Dutch soil that constitute one of Europe's most remarkable conservation efforts.

The Oostvaardersplassen is the world's most visible example of Pleistocene rewilding, the idea of reintroducing the megafauna that man wiped out as he spread across the globe. The idea is more popular in theory than in practice. There is a rewilding park in Siberia, with Yakutian horses, wisent, wapitis and muskox, but hopes to reintroduce America's megafauna have got no further than releasing some large Mexican tortoises in a ranch owned by Ted Turner, a media mogul.

The Oostvaardersplassen was reclaimed from the sea in the 1960s and intended for use as an industrial estate, but in the gloom of the 1970s it lay vacant. The idea of reintroducing Pleistocene fauna came from Frans Vera, a government scientist. He got hold of some Heck cattle, a German attempt, under the patronage of Hermann Göring, to recreate aurochs (strong, wild creatures untainted by domestication or foreign stock) by breeding primitive cattle from zoos. From Poland he imported Konik ponies, said to be descended from tarpans, the last of Europe's wild horses. He shipped in red deer, which were among Europe's original inhabitants.



Skinny as nature intended

The population of horses and deer exploded: at the peak there were 1,200 horses. With so much grazing, the trees died, and the area turned into grassland and marsh. To Mr Vera, that offered support for his theory that pre-human Europe was not covered in forests, as has been widely assumed, but was primarily grassland. Vast numbers of birds arrived, including 29 endangered species. Sea eagles started to breed in the Oostvaardersplassen in 2006, and have since spread beyond its borders.

As the herbivore populations grew, food supplies became thinner, and so did the animals. That was when the political problems started. Animal welfare is a big issue in the Netherlands: Partij voor de Dieren (Party for the Animals) holds two seats in the House of Representatives and

one in the Senate. A video clip of a starving red deer calf shown on prime-time television did not help. "There was an uproar," says Hans Breeveld, the park's warden. "People were asking how this could happen in a civilised society."

The Oostvaardersplassen has twice been investigated by government committees. It survived, but with its freedom constrained. These days its managers are required to undertake "early reactive culling"—a polite phrase for shooting animals before they starve to death. The political pressure has lessened, partly because starvation brought herbivore numbers down sharply, but plans to expand the reserve have been put on hold.

As a sight, the Oostvaardersplassen is extraordinary. In one of the world's most densely populated regions, Amsterdam now has a wilderness beside it that looks like a bit of African savannah, with herds of grazing herbivores and flocks of birds wheeling above them. Its scientific value is limited by the absence of the large predators that in the Pleistocene era would have kept herbivore numbers down. They would help settle the debate about whether ancient Europe was grassy or forested.

They may not be absent for long. In July a dead wolf was found in the Netherlands for the first time since the 19th century. More will follow: thanks to legal protection from the EU and to growing land abandonment, wolves are spreading through western Europe. If they get to the Oostvaardersplassen, they should provide added interest for the commuters.

► ecosystem of the soil—bacteria, fungi, protozoa, nematodes, microarthropods—is even more extraordinarily diverse. In a gram of soil there may be as many as a million species of bacteria. Their interactions with the food we eat and the air we breathe are complex and crucial to the production and maintenance of life. The combination of their importance and our ignorance suggests that humans would be wise to show humility in their dealings with other species, even when they are invisible to the naked eye.

All these factors have led to a big shift in attitudes towards nature. One of its manifestations has been a boom in green NGOs. Many trace their origins a long way back: Britain's RSPB, for example, was founded in 1889 to campaign against women using exotic feathers in their hats, and the Sierra Club was established in 1892 to support Yosemite National Park, founded two years earlier. But the 1960s were a particularly fertile period. The World Wildlife Fund (now the Worldwide Fund for Nature) was set up in 1961, the Environmental Defence Fund in 1967, Friends of

the Earth in 1969, and Greenpeace came together in the late 1960s. This was also the period when membership of some of the older organisations took off.

The NGOs have helped improve other species' prospects in a couple of ways. Members' contributions finance programmes, for instance to buy land, restore degraded habitat and protect species. In America and Britain, many big conservation efforts have been backed by NGOs or philanthropists. The NGOs' lobbying efforts also make an impact. As membership of conventional parties has shrunk, theirs has boomed (see chart 2, previous page). Whether there is a causal connection—and if there is, which way the causality runs—is moot, but there is no doubt that the influence of green campaigners over mainstream politics has grown. In part, it is manifested through pressure from the NGOs on the big parties, but in some countries, such as Germany, Belgium and Brazil, it has made a difference to mainstream politics. By way of laws, regulation and subsidy, human behaviour towards other species is changing. ■

Political responses

Where eagles dare

The more prosperous countries now favour protecting wildlife, not killing it

THE LAST CATS on Ascension Island in the south Atlantic held out in the volcanic rocks around Cricket Valley, on the eastern tip of the island. They were all female: according to Mike Bell of Wildlife Management International, a New Zealand company, who was in charge of eradicating the island's 500 or so feral cats, females tend to be shy and wary of potential traps. Mr Bell and his colleagues tried everything: fish, cat biscuits, day-old chicks, traps of all shapes and sizes. Eventually, on January 30th 2006, about six months after they had expected to finish the job, they trapped the last one—"a scruffy tabby, quite small"—and for the first time in 200 years the islands were safe for birds.

In 1815, when the island was first garrisoned by the British, around 20m birds are thought to have been living on it. By 2000, thanks largely to the offspring of ships' cats, the numbers were down to a few hundred thousand. The rocks were covered with ghost seabird colonies—miles of stony ledges covered in guano deposited over millennia, with hardly a bird to be seen. The Ascension frigate bird, endemic to the island, had been driven to nesting on an offshore rock the cats could not get to.

Most eradications of undesirable species have been carried out on unpopulated islands, but Ascension has people—soldiers and spies, mostly, manning the British military base and listening post. Many of them had adopted cats from the feral population. Around a third of the tame cats died, which caused some contretemps between locals and eradicators.

The eradication programme may not have worked out for some of the cat owners—though since the human population is transient, the bereaved may have found feline love elsewhere—but the bird population is rebounding, and last year the Ascension frigate bird nested on the island itself for the first time in 150 years. Credit goes to the RSPB, which organised the eradication programme, and the British government, which paid for it.

Programmes to get rid of invasive species are one way in which governments, with varying degrees of enthusiasm and effectiveness, try to tackle threats to other species. Others are laws against killing endangered creatures or trading in them, regulations to make pesticides safer and protection of habitat.

Nobody much cared about the killing of wildlife until well into the 20th century. The American bald eagle, for instance, was routinely slaughtered throughout the 19th and the early part of the 20th century because it was believed to prey on lambs and even children. Benjamin Franklin opposed its selection as a national emblem, arguing that the eagle "is a bird of bad moral character." Numbers dropped from up to half a million in the 18th century to 412 breeding pairs in the early 1960s. Now that killing them has been outlawed, there are reckoned to be 7,066 breeding pairs.

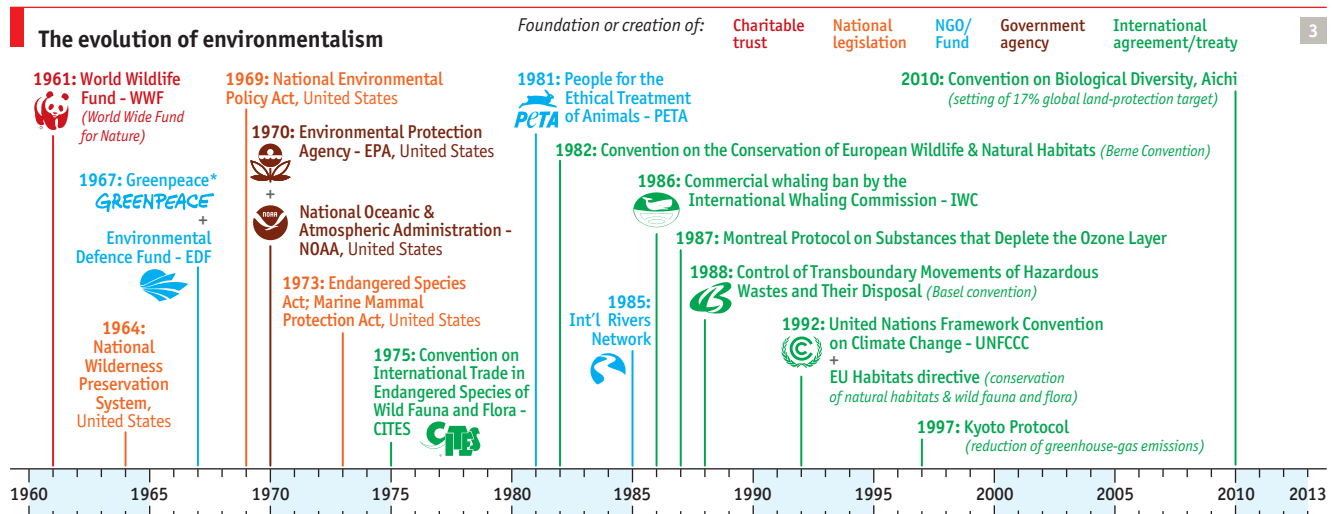
Crying wolf

As the environmental movement took off in the 1960s, wider laws followed, mostly in the 1970s and 1980s. America's Endangered Species Act was signed into law in 1973 by Richard Nixon. Europe's Berne Convention, ratified as national law among its signatories, came into effect in 1982. The bans on killing were of particular benefit to predators which people regarded as a threat to their lives or livelihoods. Wolves, lynx and wolverine all nearly got wiped out in western Europe and are all doing pretty well these days—too well, in the eyes of many farmers and hunters. In the Great Lakes and the north-west of America, the wolf population has recovered so strongly that it has become a big political issue.

Whales are generally thought to be recovering, too, thanks to whaling bans. The humpback, which has been protected longer than other species, is known to be flourishing. Whaling still goes on—some countries ignore the ban, and Japan gets special licences for "scientific" whaling—but there is far less of it.

Trade in endangered species has been limited through the Convention on International Trade in Endangered Species (CITES), which came into force in 1975 and covers about 34,000 species, the best-known being elephant and rhino. It worked pretty well for them to start with, but rocketing demand for ivory and rhino horn has proved irresistible (see box on next page).

Pesticide regulation, too, has been tightened over the years, partly thanks to Rachel Carson. She not only exposed the dan- ►



► gers of DDT but also campaigned to create the Environmental Protection Agency (EPA), pointing out that America's Department of Agriculture, being responsible both for promoting the farmers' interests and for regulating pesticides, was suffering a conflict of interests. Before the EPA was created in 1970, pesticides had to be registered but were virtually unregulated. Now the EPA requires new pesticides, or pesticides being used in new ways, to undergo around 100 different tests, which takes around two-and-a-half years. Regulation in Europe, partly the responsibility of the European Commission and partly of member states, is tougher still. Getting a pesticide from the lab to the market takes seven or eight years, and pesticides cannot be marketed if they leave residues of more than 0.1 micrograms per litre of water, irrespective of their toxicity. Earlier this year the EU agreed to impose a temporary ban on neonicotinoids, which are thought to be implicated in the decline of bee populations, though they are still being used in America.

Invasive species have been solely responsible for 20% of extinctions since 1600 and partly responsible for half of them. These days huge efforts are made to combat such species, through both prevention and eradication. Most countries have customs regulations to stop them entering in the first place.

Over 1,200 eradication programmes have been carried out, mostly on islands, which tend to have a high proportion of vulnerable endemic species and where eradication is relatively easy. Piero Genovesi, chairman of the specialist group on inva-

sive alien species of the International Union for the Conservation of Nature (IUCN), says that 86% have been successful.

Not all have had the intended effect: on Macquarie Island, a World Heritage site between New Zealand and the Antarctic, the eradication of cats (introduced in 1820) led to an epidemic of rabbits (introduced in 1878) which devastated the native vegetation. But most have benefited local wildlife, and sometimes the local economy too. For instance, the eradication in the 1980s of coypu in Britain, which had escaped from fur farms, cost around €5m but is reckoned to have saved the country a lot of money. According to Mr Genovesi, Italy, which still has coypu, has spent €11m euros over the past six years on mitigating the damage they do, and the costs look like rising further.

Somewhere to live

The biggest challenge for governments, and the area where most effort and resources have been focused, is habitat loss. The main means of limiting it is to create protected areas such as national parks. Such efforts go back a long way—hundreds of years, if you include monarchs' reservation of hunting areas such as Bialowieza Forest in Poland, where King Sigismund I imposed the death penalty for bison poaching in 1538.

Limiting or banning development in areas of great beauty or biological value is a newer idea. America led the way with such efforts, starting with an act dated 1864, signed by Abraham Lincoln, which ceded Yosemite to California, requiring that "the ►►

Hearts and minds

Stopping the slaughter of endangered species takes imagination

IN THE 1970S and 1980s Africa's elephants were being slaughtered to satisfy demand for ivory in Asia, above all Japan. A two-pronged attack was launched to deal with the problem. On the supply side, the ivory trade was banned in 1989 through the Convention on International Trade in Endangered Species. On the demand side, Traffic, an NGO dedicated to fighting trade in endangered species, mounted a campaign to reduce demand. The combined approach worked. There are no precise numbers, but the African elephant population is thought to have increased from 300,000-600,000 in 1995 to 470,000-690,000 in 2007.

In recent years, though, demand from China has led to a resumption of the slaughter. Campaigners say that elephants are dying at a faster rate than at any time since the 1980s. Supply-side intervention is proving difficult. Kenya has recently established an anti-poaching unit and increased the penalties for poaching, but outside southern Africa governments are too poor and too fragile to counter the pull of Chinese demand. The \$10m that Barack Obama recently committed to the fight against poaching is unlikely to make much difference. Some campaigners are therefore trying to emulate the earlier demand-



reduction campaign.

Back in the mid-1980s Japan was importing 500 tonnes of ivory a year, about 50,000 elephants-worth. Two Japanese traditions kept demand buoyant: the ivory name-seals used to finalise business deals, and the preference for precious stones or ivory for the best *netsuke*, or kimono toggles. Traffic worked on the newspapers and helped persuade them to write anti-ivory editorials. But the big breakthrough, according to Traffic's Tom Milliken, came when Britain's Prince Philip gave a rousing speech at an event organised by the World Wildlife Fund, which encouraged Japan's crown prince to speak out. "It was the first time that Japanese royalty had taken a stance on a wildlife issue. It was an amazing moment," says Mr Milliken. Ivory became

uncool. He reckons Japanese imports are down to 5-10 tonnes a year.

WildAid, an NGO, is now trying to pull the same trick in China. It recently launched a campaign on television and video billboards and in taxis featuring the Chinese equivalent of Japanese royals: celebrities. The slogan goes: "When the buying stops, the killing can too." Yao Ming, a basketball player who is one of the stars featured (pictured on the cover of this special report), has been to Africa to make documentaries on elephant and rhino which WildAid hopes will be screened next year. A campaign he headed to discourage people from eating shark fin augurs well: demand is said to be down by half, and the government recently announced a ban on shark fin at official banquets.



A howling success

► premises shall be held for public use, resort, and recreation; shall be inalienable for all time.” But the first truly national park was Yellowstone, established in 1872. There was opposition from local interests more concerned about development than scenery, but Theodore Roosevelt, a young and eloquent congressman, helped persuade Americans it was a good plan.

Slowly, parks started to spring up around the world—mostly, to start with, in British colonies such as Canada, Australia and New Zealand. Sweden set some up in 1909, but Europe was generally slower to get going than America, possibly because its land was scarcer and its landowners more powerful. Britain got its first parks only after the second world war.

These days more and more land is being protected. A study in 1985 suggested that 3.5% of the planet’s land area was protected at the time; another in 2009, by Clinton Jenkins of the University of Maryland and Lucas Joppa of Duke University, found that the figure had gone up to 13%. The 2010 Aichi meeting of the signatories of the Convention on Biodiversity set a target of 17%, which gives the recent progress may even be met.

Protecting land is not always popular. Many parks were established by philanthropists in the face of public opposition. Grand Teton, for instance, was created from land owned by John D. Rockefeller. There was so much opposition to his plan that Franklin Delano Roosevelt used an act which allowed the president to set aside land as a national monument to avoid having to go through Congress. Foreigners have an even harder time of it. Doug Tompkins, founder of Esprit, a fashion retailer, has bought up around 2m acres of Chile and Argentina which he plans to hand over to the state, but locals have been far from enthusiastic about his determination to keep it pristine.

Yet it is not just rich people, or rich countries, that want to protect ecosystems. The biggest increase in protected areas in recent years has been in Brazil. China created its first national park in 1982; it now has 1,865 of them, covering 110m hectares, three times the area of America’s parks (though since the level and nature of protection afforded by national parks differs between countries, they are not strictly comparable). A recent paper by Canadian and Chinese academics attributes this growth to the creation in 1995 of the five-day working week as the norm, and the subsequent introduction of “Golden Week” holidays. Chinese people, like the rest of humanity, want to escape their factories and enjoy nature as they become more prosperous. ■

The effects of growth

The long view

Contrary to popular belief, economic growth may be good for biodiversity

COMPARISONS BETWEEN ADJOINING countries separated by politics or economics can be instructive. North Korea’s forests have been shrinking by around 2% a year for 20 years; South Korea’s are stable. Satellite pictures of the island of Hispaniola in the Antilles show that the western side (Haiti, with a GDP per person of \$771 a year) is barren, whereas the eastern side (Dominican Republic, GDP per person \$5,736) still has plenty of dense forest.

Economic growth is widely believed to damage species other than man. But as the contrasting fortunes of forests (a fair proxy for biodiversity) on the Korean peninsula and Hispaniola suggest, it is not so much growth as poverty that reduces biodiversity. Poverty without growth, combined with lots of people, is disastrous. Poverty combined with growth can be equally calamitous. But once people enjoy a certain level of prosperity, the benefits of growth to other species outweigh its disadvantages.

There appears to be an environmental version of the Kuznets curve, which describes the relationship between prosperity and inequality in an inverted U-shape. At the early stages of growth, inequality tends to rise; at the later stages it falls. Similarly, in the early stages of growth, biodiversity tends to suffer; in the later stages it benefits. The Living Planet Index (LPI), put together by the Zoological Society of London and WWF (see chart 4, next page), shows a 61% decline in biodiversity between 1970 and 2008 in tropical areas, which tend to be poorer, but a 31% improvement over the same period in temperate areas, which tend to be richer. Similarly, poor countries tend to chop down forests, and rich countries to plant them (see chart 5, next page).

Some of the improvement might be due to rich countries exporting their growth to poorer countries, but that is clearly not the only factor at work. Nobody exported growth to North Korea and Haiti, and their environments still got trashed. Meanwhile in countries that were poor until fairly recently—such as South Korea and Brazil—things are looking up for many species.

The evidence suggests that, above a fairly low level of income, economic growth benefits other species. As the previous article showed, when people get richer, they start behaving better towards other species. And as countries grow they become cleaner, more urban, more peaceful, more efficient and better-informed, and their people have fewer children. Other species benefit from all those effects, and from the scientific and technological progress that comes with growth.

Though all species benefit from fresh water, it is principally for their people’s benefit that societies clean up their rivers. London started building its sewage system the year after the “Great Stink” in 1858 because many people were dying of cholera and life in the city became unbearable. Parliament temporarily had to move out of its premises on the bank of the Thames. In the 1960s President Johnson called the Potomac a “national disgrace” not so much because it killed fish but because it was filthy. Shortly afterwards he signed the Water Quality Act. Forty years ago two-thirds of America’s rivers were unsafe for swimming or fishing. Now only a third are. A clean-up programme designed primarily to benefit people was good for other species too.

Even after sewage treatment had become widespread, riv- ►►

► ers were still being poisoned by industrial effluent and pesticides. Controls on those pollutants have done their bit to help clean up rivers. Britain's Environment Agency says that in 1990 the water quality in 55% of rivers was graded good or excellent; now the share is 80%. That not only makes the rivers safe for recreation, it has also encouraged the return of once-common creatures that became rare in the 20th century. Otters, for instance, were present in only 6% of 3,300 sites surveyed by the Environment Agency in 1977-79; in 2009-10, they had spread to 60%.

When countries get richer, farming tends to become more intensive. Output increases, marginal land is left fallow, the agricultural labour force shrinks and people move to the towns. Abandoned land is used for recreation and turned back to forest or wilderness. That is the main reason why in 2005-10, according to figures from the United Nations' Food and Agriculture Organisation, forest cover grew in America and was stable or increasing in every country in Europe except Estonia and Albania.

Sharing or sparing?

Many greens argue that intensification of agriculture harms biodiversity. It is true that pesticides and fertiliser tend to reduce the number of species where they are used, but intensive agriculture employs less land than extensive farming to produce the same amount of food. The question, then, is whether the net benefits to other species of "land-sharing" (farming extensively on a larger area) outweigh those of "land-sparing" (farming intensively on a smaller area). A couple of recent papers—a theoretical one by David Tilman of the University of Minnesota and an empirical study by Ben Phalan of Cambridge University, looking at data from Ghana and India—suggest that land-sparing wins.

Richer countries tend to be better informed about the value of ecosystems and take a longer view. That is why China, having destroyed so much of its forest, is now paying its farmers to plant trees. The ecological value of some of the resulting forest is open to doubt—a lot of it is monoculture of imported varieties that do not always suit the local climate—but the numbers are impressive. Forest cover increased by a third between 1990 and 2010.

Better-off countries also have more effective governments, without which conservation would be impossible. Elephants are doing better in southern Africa than in East or Central Africa. South Africa, Zimbabwe and Botswana all have well-administered parks and reasonably effective police forces; in Congo, Chad and Tanzania, those institutions are shakier.

Richer countries are generally more peaceful, too. That is

good for their people, but not always for other species. Biodiversity sometimes benefits from conflict: where it keeps people out, it may conserve habitats for other creatures. The 1,000-sq-km demilitarised zone between North and South Korea, for instance, has become a de facto nature reserve of great interest to scientists. On balance, though, conflict tends to do more harm than good to biodiversity, destroying habitats and undermining states' efforts to protect other creatures. That is another reason why elephants are doing better in southern Africa than in Central and East Africa, where militias have plenty of guns and a financial interest in selling ivory to fund their wars.

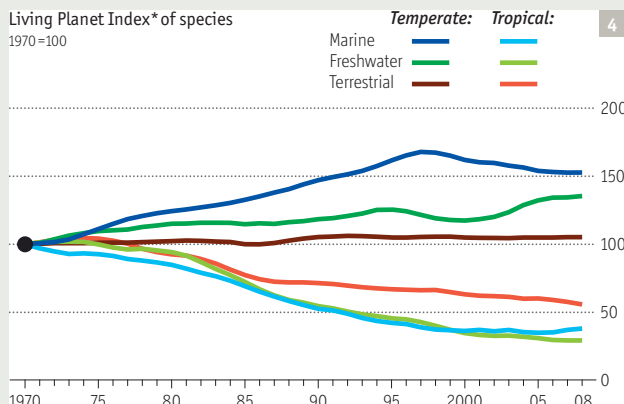
The impact of prosperity on human demography also benefits biodiversity, but it takes time. In its early stages economic growth often causes people to multiply faster as death rates come down but birth rates stay high, as is happening in Africa now. That intensifies competition for resources between humans and other species. But when countries become richer, more women get educated and take jobs, more people move away from farms and into cities and birth rates start falling. In East Asia fertility has fallen from 5.3 children per woman in the 1960s to 1.6 now. In some countries—Japan, Russia, much of eastern Europe and some of western Europe—the population is already declining. But in Africa it is still rising fast, which is the main reason why the UN expects the world's population to continue expanding to the end of this century.

Lastly, growth brings scientific advance, which makes it easier to mitigate threats to biodiversity. So far conservation has been dominated by men in shorts with not much more than a pair of binoculars. Now the digital revolution is transforming it. The data are building up and becoming easier to access. Three centuries-worth of information on natural history is sitting in museums and universities around the world, and is now being digitised. The Global Biological Information Facility, an intergovernmental effort, is working to make this information available to everybody, everywhere.

The IUCN's Red List, globally recognised as the repository of information about endangered species, was started as a card-index system in 1954 by Colonel Leofric Boyle, a British army officer who helped to save the Arabian oryx. Now it is online and accessible, but still not much more than a list. Microsoft Research, through a partnership with the IUCN, is building a platform on which scientists all over the world will be able to map the threats to the species they are interested in and discover threats posted by other scientists. ►

Where the wild things are

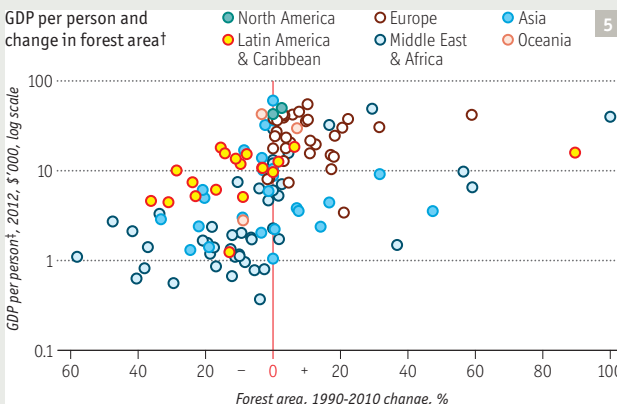
Living Planet Index* of species
1970=100



Sources: FAO; IMF; WWF; ZSL; The Economist

ONLINE: Explore an interactive version of this scatter chart at Economist.com/bioscat13

GDP per person and
change in forest area†



*Based on population size, density or abundance

†Countries with population over 3 million

‡At purchasing-power parity



Returning to a river near you

► The display of data is getting better, too. ESRI, a technology firm that dominates the mapping business, enables users to build up maps with layers of information on them. It provides its software free to conservation organisations and has moved it onto the cloud. David Yarnold, the boss of America's Audubon Society, says his organisation had data on land use, hydrology and 114 years of bird counts from 470 local groups, none of it shared. Now, thanks to ESRI, all of it is accessible.

Communications technology can also help collect information on wildlife movements. Large animals—elephant, giraffe, lion, hirola—are now often fitted with GPS collars to track them. Miniaturisation is opening up new uses for such tools. Technology for Nature—a collaboration between Microsoft Research, the Zoological Society of London and University College London—is developing “Mataki tags”, tiny devices attached to animals that can relay information wirelessly and communicate with each other. The idea is that a tag on, say, an elephant will download its information to a tag on, say, an oxpecker—a bird that rides on an elephant's back—and all the information will be downloaded to a base station near the oxpecker's nest.

The most useful technology for conservation is remote sensing, now widely used for monitoring deforestation and species distribution. Peter Fretwell of the British Antarctic Survey, for instance, has been using remote-sensing data to estimate penguin populations from guano stains. The data can distinguish between different kinds of penguin because the infrared signature of the guano varies between species. As a result he has doubled his estimate of emperor-penguin numbers.

The tools are improving and getting cheaper. Serge Wich, professor of primate biology at Liverpool's John Moores University, has been using drones to calculate orang-utan densities in the Indonesian rainforest. Orang-utans make a nest every day—“quite comfortable ones, with a blanket woven from branches”, explains Mr Wich—so orang-utan populations can be guessed from nest numbers. “We were slogging through the rainforest thinking how nice it would be to have a camera fly over it to monitor nest frequency,” he says. But he assumed it would be too expensive—until he found an American website, diydrones, which enabled him to make one for \$700. A bunch of conservation organisations has set up ConservationDrones.org to share information about this handy tool; Research Drones, a Swiss company, makes drones specifically for environmental and research purposes. “It's our hope that an unmanned aerial vehicle will become like a pair of binoculars,” says Mr Wich.

Remote sensing, combined with economic progress, has also helped sharply to reduce deforestation in Brazil—the most important country for biodiversity. ■

Brazil's conversion

Trees of knowledge

How Brazil is using education, technology and politics to save its rainforest

MAURO LUCIO IS living the dream. Having started work as a cowboy at 16, he is now 48 and raises cattle on 50 square kilometres of Paragominas municipality in Pará state. The animals on his ranch are healthy, the grass thick and the fences solid. Along the avenues on his estate, wooden posts name the many different varieties of trees he has planted between the fields. His wife serves delicious food while his three daughters play happily on the verandah of the handsome wooden ranch house.

The only thing that is not ideal about Mr Lucio's estate is its history. Until around ten years ago it was part of the rainforest. The biggest trees, up to 100 feet tall, were sold for timber, the rest burnt. In this way Brazil has lost around 19% of its Amazonian forest. And Brazil makes up around 63% of the Amazon region.

Half of the world's plant and animal species are believed to live in rainforest, so destroying it is a sure way of wiping out large swathes of biodiversity. Species are put at risk not just when forest is burned but also when clearing cuts up the remaining forest into smaller and smaller fragments. A study conducted over three decades by Thomas Lovejoy, an American scientist, shows that creatures die when the forest becomes more and more fragmented, partly because it dries up and partly because some species are deprived of the range they need to survive.

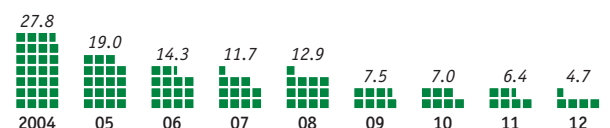
Until recently it would have been normal practice in the area for Mr Lucio to occupy his ranch for a few years, then, when productivity dropped—as it tends to on the rather thin rainforest soil—burn down some more and move on. But Mr Lucio has no plans to do that, nor, if they are to be believed, do any of the other ranchers in Paragominas. Burning down the rainforest, in addition to having been outlawed, has also become socially unacceptable. Mr Lucio is focusing on raising his income not by colonising more land but by increasing his farm's productivity.

Space-age solution

When Luiz Inácio Lula da Silva became president in 2003, his government, under pressure from public opinion and foreigners, turned against deforestation. From 2003 his environment minister, Marina Silva, started giving greater protection to land in the Amazon and beefed up the federal environmental police, the Ibama. Centres of illegal logging, such as Paragominas, were put on a blacklist.

Ms Silva was greatly helped by a combination of remote sensing and a Brazilian NGO, Imazon. Brazil's space agency published figures on deforestation, but only on an annual basis, ►►

Can't see the deforestation for the trees

Annual deforestation in the Brazilian Amazon, '000 km²1x ■ = 1,000 km²

Source: Imazon



Logging off

► nearly a year in retrospect and without a map, so nobody knew exactly where the trees were coming down. Beto Verissimo, who founded Imazon to use science for the benefit of the rainforest, realised that NASA's Modis satellite collected data that could be published monthly and would also show where the damage was being done. In 2007 Imazon started processing NASA's data and publishing them within a few weeks of being collected.

Partly because of rising prosperity and partly because of international attention, Brazilians were getting more interested in the fate of the Amazon. Newspapers started putting Imazon's data on their front pages. State governors had to respond to them on national news programmes. Month after month, Mato Grosso and Pará were found to have the highest rates of deforestation.

In 2008 the government ratcheted up the pressure, publishing a list of the 36 municipalities with the worst records. Seventeen, including Paragominas, were in Pará state. Being blacklisted did not just bring public humiliation to the citizens of Paragominas, it also hit their wallets. Businesses in municipalities on the list were not eligible for cheap credit from state-owned banks.

Adnan Demachki, Paragominas's mayor, saw that Greenpeace's boycott of soya produced from Amazonian estates was hitting the soya farmers of Mato Grosso and realised that something similar was about to happen to the beef producers of Pará. He went round making speeches to local groups to persuade them that deforestation had to stop.

The federal public prosecutor in Pará, Daniel Avelino, followed the supply chain back from the supermarkets through the beef companies to the ranchers to find out which animals had been produced on illegally deforested land, and threatened the supermarkets with prosecution. "They reacted fast," says Mr Avelino. "It was about their brand, their visibility to the public." Brazil's supermarket association—which includes Walmart and Carrefour—said its members would stop buying beef from recently deforested land.

This made Mr Avelino exceedingly unpopular. He received death threats and still travels with an armed guard. But he was not alone in applying economic pressure. The International Finance Corporation, the private-finance arm of the World Bank, withdrew a loan it had promised to Bertin, a big beef producer, to expand its facilities in the Amazon.

Mr Demachki persuaded local trade associations to commit to stopping deforestation. In April 2008 he fined three farmers who were still at it. In October 2008 he was re-elected with 88% of the vote. But not everybody liked what was happening, and things came to a head that November night when the environmental-police station went up in flames.

Since then deforestation in the municipality has pretty much stopped and Paragominas has become a model town. It has a Green Lake, a Green Stadium and a Green Park in the centre of town. A museum built from illegally felled, confiscated wood shows, with admirable neutrality, how Paragominas performed its U-turn on deforestation. Since the 1960s two-fifths of the municipality has been cleared of forest. The plan is for about 15% of the cleared area to go back to forest, and half of the rest to be left to cattle-ranching and half to arable farming.

In 2011 Simão Jatene, Pará's newly elected governor, decided to replicate Paragominas's achievements around the state. Central to this effort is the Cadastro Ambiental Rural (CAR), the rural environmental registry. Uncertainty about land tenure is a big administrative stumbling block in Brazil. Some farmers do not have title to the land they farm; some give money to people in whose name land is registered, known as *laranjas*—oranges—so that the real owners are not held to account for deforesting it. "If you have a speed trap but the cars have no numbers, that's useless," says Mr Avelino. Rather than try to delve into the history of every piece of land, the state governments in Mato Grosso and Pará are trying to get farmers to apply for a CAR certificate so the government knows who is using the land and how much forest it is supposed to have. Banks now require loan applicants to produce a CAR; beef companies will buy only from farms with a CAR. In Pará the number of properties with a CAR has gone up from 600 in 2009 to 80,000 now.

Deforestation in Pará has more or less come to a halt. In the Brazilian Amazon as a whole, it has fallen from 28,000 sq km in 2004 to under 5,000 sq km last year (see chart 6). Although small farmers continue to clear land in areas where the authority of the state is weak, the big beef and soya companies that used to do it themselves or buy produce from those that did no longer want anything to do with it.

Brazil's success—so far—demonstrates how many elements have to come together to make such policies work. You need clear direction not just at the top but all the way through government. Ms Silva's determination was crucial, but if her views had not had the support of Mr Jatene, Mr Avelino and Mr Demachki, she would not have got far. You need administra- ►►



► tors with enough imagination to find novel solutions: the CAR was a way around an apparently insuperable land-tenure problem. You need a functioning police force: if the Ibama had not been effective, the politicians' and prosecutor's intentions would have been impossible to implement. You need businessmen whose conscience or share price induces them to change their supply chains. You need NGOs, such as Greenpeace and Imazon, to badger business and government to do things differently. You need independent media to pick the story up and run with it. And, crucially, you need a public that cares: if voters and consumers were indifferent, none of this would happen.

Help from foreigners, especially Americans, has been important too—though, given Brazilian sensitivity to interference by gringos, some of them keep quiet about it. Imazon's Mr Verissimo was inspired by Chris Uhl, an American field ecologist working in Pará in the 1980s who is now a professor at Penn State. Imazon was founded with grants from USAID and the MacArthur Foundation. The Ford Foundation funded a sustainable forestry project in Paragominas. NASA provides the satellite data that Imazon publishes. Google has built a platform to allow Imazon to process the data more quickly and cheaply, and Imazon is now training people from other rainforest countries to use it. Mr Lovejoy's forest-fragments project has been running for 30 years, bringing in a stream of foreign researchers, employing Brazilian scientists and pointing out the consequences of slicing the forest up into little bits. Greenpeace's international campaign against Brazilian soya, beef and leather put pressure on global businesses such as Walmart, Carrefour and Nike, and that put pressure on Brazilian companies. So although globalisation exacerbated deforestation by boosting demand for Brazilian produce, it is also part of the solution.

Keep at it

But the problem is still not solved once and for all. Deforestation rates may rebound. If locals can prosper without chopping trees down, there is a good chance that the rest of the forest will survive. If they can't, it won't.

Migration should help. These days it flows away from the Amazon rather than towards it. Brazil is urbanising fast, and the attractions of scrubbing a living from raising cows on deforested land are diminishing.

Still, there are plenty of people left in the countryside, and stopping deforestation means destroying jobs. In Paragominas only 14 of the city's 240 sawmills are still working, and the charcoal industry has closed down. Yet after a brief downturn, the city is doing pretty well. One reason is in evidence in the town hall, where about 50 ranch hands in cowboy hats and baseball caps listen raptly to a presentation on human-bovine interaction. "Control by understanding animal behaviour," says a slide, "not by aggression." "Suffering in the cow represents loss of quality in the meat," says another.

The course is part of a Green Ranching Project, run by Mr Lucio in his capacity as head of the local branch of the farmers' union. Better animal welfare is a by-product: the initiative's main aim is to increase output so that farmers can prosper without deforesting more land. Mr Lucio's farm shows it can be done. Average production for the region, he says, is 90kg of beef per hectare per year; his average is 500kg and his profit margin 40%. Other than happy cows, his secrets are dietary supplements in their feed, fertiliser for the grass, allowing pastures to regenerate after 48 days of grazing and planting copes in his fields to shelter his cattle from the heat.

The combination of better education and chemicals means that farmers like Mr Lucio can prosper without destroying the forest. This is progress from which all species can benefit. ■

The outlook

Averting the sixth extinction

Growth is good, but governments need to continue to regulate it and greens to learn to love it

OVER THE GRAND sweep of history and geography, things have not been going well for Earth's non-human species. Extinction rates over the past few centuries have been far higher than the background rate, and taking the world as a whole the picture over the past few decades has been looking pretty bleak. The Living Planet Index shows a 30% decline in biodiversity since 1970.

Take a closer look, though, and a more optimistic account of the planet's trajectory emerges. What limited information on extinctions is available suggests that trends have improved recently. Although the LPI shows a global fall in biodiversity, and a stark decline in poorer countries, in richer countries conditions are improving for other species. That is thanks to the developments covered in this special report—shifting public attitudes to other species, increasing appreciation of natural environments, legislation to stop the killing of endangered species, programmes to eradicate invasive species, more and bigger protected areas for wildlife, subsidies to restore degraded habitat, better sanitation, better regulation of pesticides, decreasing levels of conflict and increasingly effective states implementing conservationist legislation. All of these become more prevalent as countries get richer.

Yet the survival of most of the planet's remaining non-human species is by no means assured. Leaving aside the huge unknown of climate change, whether or not the sixth great extinction is looming depends largely on what happens to growth and how humanity manages that growth.

Faster growth will mean higher consumption of resources and more pressure on habitat, which is bad for other species. But as North Korea's experience shows, the combination of economic stagnation and poverty is even worse. Growth can benefit biodiversity, so long as it is combined with regulation and investment to protect other species. That has happened to some extent; whether it happens enough to prevent biodiversity being drastically reduced depends largely on governments in emerging markets.

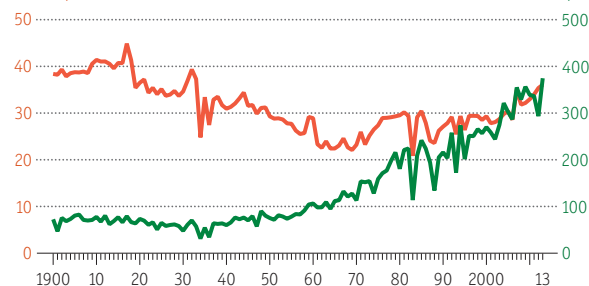
But the biggest question of all for other species is what happens ►►

All ears

US corn

Harvested area,
hectares, m

Production,
tonnes, m



Source: USDA

► pens to land use. With habitat loss the principal threat to biodiversity, and agriculture taking up two-fifths of land compared with 3% for urban areas, the demand for food, and how it is met, will determine how much land is left for other creatures.

According to research led by David Tilman of the University of Minnesota, demand for food is likely to double by 2050. The UN's central estimate is for the world's population to rise by a third over that period, from 7.2 billion to 9.6 billion, but demand for food will grow faster than that, because as people get richer more of them will get enough to eat and more will be able to afford more meat. Meat consumption per person in China has risen from 4kg a year in 1961 to 58kg in 2009. In Britain it is 84kg.

Assuming that current levels of wastage persist, if demand for food were to double and crop yields remained the same, the amount of land cultivated would need to double as well. Since around 40% of the land on the planet is already cultivated, that would not leave much room for other creatures. But if farming were to become twice as productive, there would be no need to till any more land. Over the past 60 years America's corn farmers have done better than that: production has quadrupled on an area that has increased by half (see chart 7, previous page).

Loaves and fishes

For agriculture to pull off the same trick again would mean either boosting yields in high-yielding countries yet further or intensifying agriculture in low-yielding countries. The first may be hard to do: agricultural tech companies are struggling to get any more yield out of cereals growing in favourable conditions. But there is clearly scope for the second. In America, for instance, corn (maize) yields are around 7.7 tonnes per hectare, compared with 2.5 tonnes in India.

Boosting yields means using more fertiliser, pesticide and GM seeds. Some environmentalists understand this, but few publicly support the intensification of agriculture. Attitudes to GM among the big NGOs range from the RSPB ("maintains an open mind") and WWF ("precautionary approach") to Greenpeace ("a serious threat to biodiversity and our own health") and

Friends of the Earth ("unnecessary risks to both humans and nature"). Among green political activists, hostility to the intensification of agriculture is near-uniform. In consequence, GM seeds are, in effect, banned in the European Union (though EU citizens feast on GM products freely imported from other countries) and rich-world activists have exported their opposition to GM crops to Africa and Asia.

Hostility to intensive agriculture within the green movement is understandable. Environmentalism was partly a response to "Silent Spring". Opposition to companies like Monsanto and Syngenta is bred into the green movement. So is hostility to growth: environmentalism's roots lie in the Romantic movement that sprang up in opposition to the industrial revolution. Deep in the green movement's soul lies a belief that the wrongs done to the planet were caused by technological change and economic growth, and that more of them can lead only to greater evil.

It is true that if man had never sharpened his first spear, the mastodons would probably still be roaming the plains of North America and the aurochs the grasslands of Europe. But it is wrong to conclude from this that more growth and more technological change would compound the disaster. For the first time

since he got the upper hand, it looks as though man may succeed in averting the sixth great extinction, for a series of inter-connected reasons.

As mankind has got richer, he has set about cleaning up some of the mess that he has made of his surroundings. Growing prosperity has induced him to care about matters beyond his own survival and that of his tribe and to translate those concerns into laws, regulations and programmes, both publicly and privately funded, that have changed people's behaviour towards their environment. At the same time, the technological progress that has accompanied economic growth has not just made conservation more effective but has also enabled man to produce more of what he wants from less, to the benefit of other species.

Many in the environmental movement regard economic growth and technological progress as enemies of biodiversity. Actually, they are its friends. Only through more of both can man hope to go on enjoying the company of the 8.7m or so other species with which he was born to share this planet. ■



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