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Planet Earth, The Future

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Jonathon Porritt

planet earth - the future

planet earth the future

Environmentalists and biologists,
commentators and natural philosophers

IN CONVERSATION WITH

Fergus Beeley

Mary Colwell and Joanne Stevens

BBC
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Foreword

by Jonathon Porritt

‘So what are you guys going to do when that elusive tipping point of yours actually tips - and everybody *really* starts getting it? It won't be long, you know, and then you'll all be out of a job!’

These words - from one of today's world-weariest and most cynical of media commentators - made me laugh out loud. The idea of being out of a job because the whole world is suddenly ‘doing sustainability’ is too delightful a prospect to dwell on for more than a few seconds. But the idea of that long-sought-after sustainability tipping point being imminent is certainly one to conjure with - even as the cataloguing of environmental doom and gloom grinds remorselessly on.

All those who have pitched in their twopence-worth to this wonderful project are all - in one way or another - speculating about such a tipping point. But you'll find no easy consensus. Indeed, what astonishes me today is to see how differently different people interpret the same base-line data about the cumulative impact of the human species on planet Earth's life-support systems. Some will force you with them down to the very depths of despair, while others optimistically offer up a reassuring ‘window of time’ still available to us to get things sorted.

No-one quite knows how wide a window that may be. We're now 35 years on since the UN Conference on the Environment and Human Development in Stockholm in 1972 first gave voice to the same broad analysis that you will find here. It goes almost without saying that not enough has been done to address that analysis since then; but a huge

amount has been achieved, and many destructive trends have been slowed if not, as yet, reversed.

And while there are a few who suppose we've got another 35 years, responses to this planetary crisis are both diversifying and deepening *rapidly*. In contrast to where we were 35 years ago, we seem to be getting both more worldly *and* more spiritual about it. More worldly in that you will find here all sorts of ideas for engineering some kind of accommodation with contemporary economic and political orthodoxies, embracing the power of the market, celebrating technological innovation, working with the grain of 'homo economicus' rather than against it.

And more spiritual. This text powerfully reinforces an idea that was only dimly discernible 35 years ago: that the crisis we now face is as much one of the human spirit as of ecological collapse. If there is a tipping point just around the corner, it must surely lie in the gathering realization (to paraphrase Albert Einstein!) that we cannot fashion durable solutions to today's problems based on the kind of mindsets that gave rise to those problems in the first place.

In that regard, perhaps the biggest shift of all lies in the rediscovery of our *total* dependence on the Earth's natural systems and services. It may once have made sense to assert our dominance as a species by seeking to subjugate 'the rest of life on Earth', but as we made war on nature, so we made war on ourselves.

However optimistic or pessimistic they may feel, whether they're scientists or spiritual leaders, all those whose voices you will hear in this book and in the TV series *Planet Earth - The Future*, from which these quotes are taken, are saying the same thing: now is the time to step away from those childish but increasingly lethal fantasies.

It's not quite the same thing as a populist tipping point. But the combined weight of, on the one hand, nearly 50 years of authoritative scientific research revealing the intimate workings of the natural world, and on the other

hand, of new (or rediscovered) philosophical insights about the unfolding of life on Earth over 4.5 billion years, is overwhelming. It's time for us to grow up, to become truly ourselves.

The Contributors

Dr Neville Ash, Head of Ecosystem Assessment for the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC).

Sir David Attenborough, world-famous broadcaster, television presenter and commentator on the natural world.

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Dr James A. Duke, leading medicinal-plant scientist.

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Dr James Lovelock, distinguished scientist and originator of the Gaia hypothesis.

Dr Barbara Maas, Chief Executive of Care for the Wild International.

Professor Wangari Muta Maathai, Kenya's Assistant Minister for the Environment and creator of the Green Belt Movement.

Richard Mabey, one of Britain's foremost writers and a leading commentator on nature and our relationship with it.

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Jonathon Porritt, leading writer, broadcaster and commentator on sustainable development, and co-founder and Programme Director of Forum for the Future.

Sandra Postel, leading authority on international freshwater issues and Director of the Global Water Policy Project.

Adam Ravetch, award-winning film-maker specializing in the Arctic.

Dr M. Sanjayan, Lead Scientist for the US Nature Conservancy.

Clare Short MP, former Secretary of State for International Development (DFID).

Peter Smith, Roman Catholic Archbishop of Cardiff.

Dr Mark Stanley Price, Chief Executive of the Durrell Wildlife Conservation Trust and founder and Chair of the World Conservation Union's (IUCN) Reintroduction Specialist Group.

Dr Robert T. Watson, Chief Scientist at the World Bank in the Sustainable Development Network.

Dr Rowan Williams, Archbishop of Canterbury, Primate of All England and leader of the Anglican communion.

Professor E.O. Wilson, one of the world's most distinguished biologists and thinkers, Honorary Curator in Entomology at Harvard University, leading expert on ants and promoter of the concept of biodiversity and originator of the term biophilia.

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What Extinction Crisis?

Many of the animals featured in *Planet Earth* are endangered, from the Amur leopard in Russia's Far East and the Bactrian camel in Outer Mongolia to the frogs of Central America. Does it really matter if some of them become extinct? Do some matter more than others? If we don't even know how many species there are on Earth, can we really have any idea of how many are threatened?

I don't think there's any denying that this is a crisis moment, and I don't think there's any denying that it's gotten worse in the last 30 years - that we have pushed steadily closer to the brink of disaster in many of the systems that support life on Earth.

We are now at the point where we have lost half of the world's forests, half of the world's wetlands, half of the world's grasslands. We are systematically eradicating many of the habitats that make up the world's ecosystems, and that cannot be a good thing for the animals who live there, or for the people who depend on them.

We do know that, of the species we've identified, we have perhaps one in four mammals and a third of all amphibians on the threatened list. So we know that we are progressively pushing more and more species to the edge of extinction, and we know that those species are the building blocks of the ecosystems that support life.

JAMES LEAPE

We used to have 1000 species go extinct every year. Now we are maybe losing between 15,000 and 60,000 species a year. When we discover a new species, it is a newspaper

headline because it's something exceptional. But the rate of extinction is not exceptional - it's not in the newspapers - because it's business as usual.

We have just finalized a study conducted by 1300 experts from 95 countries, and the results are really terrifying. Never have human beings destroyed the beauty that is life on Earth as we have done for the last 50 years. So, yes, we are in a crisis moment.

AHMED DJOHLAF

In human timescales, we tend to regard 10 or 20 or 30 years as quite a long time. And to that extent, those who've been hearing the call for action to avert a mass extinction of species think that it has been around for quite some time, nothing's really happened and therefore things probably aren't as bad as we thought.

But you have to remember that the timescales that biological systems are responding to are millions of years or at least hundreds of thousands of years long. And so the extinction that's taking place now and which has been going on for some hundreds of years and which is accelerating into the future - this is something that's happening in the mere blink of an eye in terms of the life of this planet. And so we do need to take a longer perspective than just a few years in terms of how serious this crisis is.

What I've understood from the data coming from countries worldwide and from the scientific community is that we now face an extinction episode on this planet comparable to that which marked the end of the dinosaurs about 65 million years ago. It's largely driven by habitat change, by the release of pollution into the environment, by global warming and by the exploitation of species directly, as well as by introductions of animals into lands where they're not native.

All these things are combining in a series of forces likely to lead, if we don't take action very soon, to the extinction of a

large proportion of this Earth's species. There is still time to do something about that, but time is extremely short.

TONY JUNIPER

Well, biodiversity has been around for billions of years now, and it's changed over time, and it's had its moments of great crisis, like when the dinosaurs disappeared. But if you ignore those moments of crisis and just look at it over time, it's been an increasing curve. So we live today easily at the greatest moment for biodiversity on Earth. The great irony is that we are living at the optimum moment to date in the history of life on Earth, and rather than glorying in it and revelling in it, we're busily collectively destroying it. It's not to say there haven't been major advances in conservation in the last 20 years, but this is a race to the finish, and so far biodiversity is losing.

THOMAS LOVEJOY

the great irony is that we are living at the optimum moment to date in the history of life on Earth, and rather than glorying in it and revelling in it, we're busily collectively destroying it

If you just lose one species, it's probably not going to have a big impact, at least nothing that you and I will recognize. But if we continue to lose loads and loads and loads of species, what we're actually saying is that the underlying fabric of nature is tearing. And that tearing will have huge repercussions for the well-being of people who live within that environment. Eventually you will get down to the point where you're not going to have water in the streams, you're not going to have forest cover, you're not going to have meat to fill your bellies, you're not going to be able to find fuel wood. That I think is the real crisis that people worry about. From an ethical or moral point of view, losing any single unique life form is a crisis, is something that I abhor.

But for the vast majority of people who live on this planet, life may be blinking out all the time, but they don't know about it, nor will they know about it even if the rates increase. But eventually what's going to happen, and it has happened in some places, is that so many things will be lost that the whole fabric of nature will have been torn apart. And that will be noticeable.

M. SANJAYAN

Human history has faced a continuous succession of crises. The species-extinction crisis that is so worrisome today may have been even worse at certain earlier times in history, at least for large animals. For example, 43 genera of large mammals became extinct within a few thousand years after the first people settled the western hemisphere about 15,000 years ago. As many as 2000 species of birds became extinct shortly after the Polynesians spread into the Pacific. So at certain moments in history, humans can have a massive impact, usually linked to new technology and an expanding population. Right now is one of those times when we're having a massive impact. We're expanding our numbers, we're expanding our economic use of resources, we're developing new technologies, and the rest of the species are suffering as a result.

JEFF MCNEELY

yes, there is a crisis, but we are the endangered species more than anything else

A moment is a different measure in human existence than in biological existence. We're not in a crisis, at least not in the next ten years. In the next century? Probably we are going to be. But I think it's us that's in the crisis more than the living systems of the planet. It's impossible to disentangle the two, but if climate change goes on unabated, there will be massive changes in the ecology of the planet, many

ecosystems will probably vanish altogether, but by no means the majority of them. Humans, though, are going to suffer very badly. The rising of the sea level, enormous human migrations out of areas where agriculture becomes very difficult. These are going to present profound problems for the human species.

In pockets way beyond our influence, life will go on, and if, as James Lovelock predicts, the crisis will in fact happen to such a degree that the human population is massively reduced and has to retreat to living in the Arctic, then obviously the rest of the planet will have a ball. And other kinds of ecosystem which are adapted to hot climates and rapid change will flourish. So I think one has to take a relativistic answer that, yes, there is a crisis, but we are the endangered species.

RICHARD MABEY

We are on the steepening curve of a wave, if birds and mammals and some of the sexier plants over the last century are typical. And there are four different lines of argument that see a further steepening of that curve over the next century. So, independent of our lack of knowledge of how many species there actually are, we can see we are on the breaking tip of what will be a sixth great wave in the extinction of life on Earth, differing from the big five previous ones, which were caused by external environmental events, by being deliberately associated with our activities.

ROBERT MAY

we are on the breaking tip of what will be a sixth great wave in the extinction of life on Earth

The effect on the imagination is different from the effect on the body. From a human point of view, we would be most saddened by losses of creatures which have become totems

for us - the great whales, the tiger. Every time I think about the tiger, I think about probably the best known poem in the English language - Blake's *The Tyger* - which every child can recite, and every child understands what it means. 'Tyger! Tyger! burning bright, in the forest of the night.' And they know that it's not just dark forest, it's to do with the pulse of life - deep down, both in our imaginations and in the world outside. And if we lose these majestic creatures with their sense of power and ancestry, and their possibility of power over us sometimes, then we as well as the ecosystem are diminished by that. We lose a measure of our own significance or insignificance when some of these astonishing creatures go.

RICHARD MABEY

We've always been in crisis moments, for particular ecosystems, particular kinds of organisms, particular species. They've been going extinct right and left - 90 species of freshwater fishes from the rivers of Malaysia, as many as 80 or more plant species wiped out by deforestation on one mountain ridge in Ecuador. But the crisis that we face now is that the rate of extinction is accelerating and that it will reach biblical proportions within a few decades.

if we tell our descendants that ... we're sorry we didn't pay attention, we're sorry we were so destructive, but we had to get on with life ... they are going to be peeved

If you go back 450 million years and then come forward, when life is on the land, the diversity was relatively low. Then it picked up considerably, with all sorts of new niches being opened and filled, and then flight came along after 100 million years or so - insects - and then other more elaborate forms of life. And as this process unfolded - that

is, life as a whole pushed harder, opened new realms, developed new specializations and became more complex and diverse - Earth was hit by a number of extinction events, of which five were catastrophic. And after each one of these, for example, the one that ended the Palaeozoic era and began the age of reptiles, and the one that 65 million years ago ended the age of reptiles, as we call it, and set the stage for the beginning of the age of mammals, these took out quite a large percentage of the species of plants and animals on the Earth, and it took 10 million years roughly for each one of these losses to be recovered by further evolution. Ten million years. And that's something to bear in mind, as we allow extinction to proceed to such horrendous levels in this present century. If we allow this to go on and do not try to slow it or halt it, then we will likely have lost as many as half of the species of plants and animals at the end of this century.

In a way it's rather comparable to the end of the age of reptiles 65 million years ago. And then if we tell our descendants that it's all right, we're sorry we didn't pay attention, we're sorry we were so destructive, but we had to get on with life - our year-by-year existence and our pleasure - and not to be concerned because evolution will restore it all in 10 million years, they are going to be peeved.

E.O. WILSON

How important is it to discover new species?

Recently I finished a pretty careful study of the most abundant ant genus - a major group of ant species on Earth. I concentrated on the western hemisphere, where this genus, *Pheidole*, is located - it's the most ecologically important single genus. And when I finished my study, with over 5000 drawings, I had a total of 623 species accounted

for, of which 344 were new to science – more than half. And now that genus amounts to about 20 per cent of all the known species of ants in the western hemisphere. It doesn't mean anything at all to discover a new species. Even birds, mammals, are coming in. Frogs are coming in – new species as the world is explored further. Something like one third of all amphibian species, including frogs known to science, have been discovered within the last 30 years. And this should make you ponder. It means that, particularly for the smallest organisms, we have virtually no knowledge at all in many critical areas of the world. We don't, for example, know enough about the nematode worms, the roundworms of the world, which make up four out of every five animals on the planet, to have any solid picture at all of the diversity of these important little animals that are everywhere in the world.

E.O. WILSON

the crisis that we face now is that the rate of extinction is accelerating and that it will reach biblical proportions within a few decades

I was at a meeting in China a couple of years ago, where Chinese palaeontologists were announcing some new discoveries of dinosaurs. How utterly irrelevant. Who cares about dinosaurs? They've been extinct for 65 million years. But everybody in the audience was spellbound by the concept of these magnificent creatures having existed. Isn't it wonderful that such a diversity of these giant reptiles dominated our planet for hundreds of millions of years. For us to know that mysterious life forms are still lurking in places that we haven't yet looked and even in places we knew well – to me, this is one of the things that makes biology so exciting.

About 1.8 million species have been described, but we don't really know how many there are. Some scientists say

10 million, some say 15, some say 100. It could even be more than 100 million if we start looking at the bacteria in the oceans, on the ocean floor, in the soil. But if we focus just on the fewer than half a million creatures we know reasonably well – the mammals, birds, reptiles, amphibians, fish and plants – the things that are closer to us, easier to see, we can use them as indicators of what is happening to the others, the more obscure forms. And that gives us ample reason for serious concern.

JEFF MCNEELY

for us to know that mysterious life forms are still lurking in places that we haven't yet looked and even in places we thought we knew well – to me, this is one of the things that makes biology so exciting

We continue to find new species at the rate of about 15,000 a year. At the same time as we are discovering new species, we're also finding that because the records are mostly so scattered and not coordinated, many of the things we thought were new species have been discovered earlier somewhere else in some other museum.

So we're resolving those synonyms at a rate that the total addition of species each year is somewhat less than 15,000, though more than 10,000 a year. Very few of these are mammals or birds. Yes, maybe one or two new bird species and several mammals turn up a year, it's a tiny percentage. Nearly all of the 10,000 or more are invertebrates – mainly insects.

ROBERT MAY

Just how many species are there?

The number of distinct species we've named and recorded is somewhere in the range of 1.5 to 1.6 million. Even that

number is uncertain, by about 10 per cent, because of the synonyms in different collections, which is astonishing. Yet we know every book in the Library of Congress, and they're all cross-catalogued. We know even less about what the total number of species may be. Conservative estimates would put it somewhere in the range of 5 to 10 million plants and animals. And so, if we took a really conservative estimate of only another 3 million to be discovered, twice as many as we currently know, and at the rate of 10,000, 15,000, 20,000 a year, that's several centuries to complete the catalogue. Even though there are ways we can speed up the cataloguing process, collecting the specimens in the first place is always going to remain the step that limits the rate at which we can do this.

ROBERT MAY

We know perhaps 6000 species of bacteria well enough to characterize them and give them a code or a name. There are that many species in a single handful of garden soil, all of those species virtually unknown. An estimate was recently made that, in one ton of soil, you can find 4 million species of bacteria - all of them, or virtually all, unknown. And you have to ask yourself, what are these species doing?

We know we depend on them for our own lives. But as we don't know what the vast majority of these creatures are, we are therefore at a considerable loss in making any firm scientific predictions about the fate of a pond, a river, a country, as we undergo these terrific changes that are occurring in climate, chemical environment, atmosphere.

We know enough to make a good estimate at least for most groups. For example, we have enough knowledge of birds, which have been quite thoroughly attended to for three centuries, of flowering plants, the same, where we believe we have knowledge of at least 80 per cent of the species, and to a lesser extent, frogs and other amphibians, and reptiles, to use these as sample groups, to determine

approximately how many species there might be in other groups, species that we still have to discover, and then how many species are going extinct globally.

in one ton of soil, you can find 4 million species of bacteria - all of them, or virtually all, unknown

Using these model groups to make the estimate with is rather like taking a random sample of people in the south of Britain and finding that 1 per cent were dying of respiratory diseases every year. You could be pretty sure that that would be the case for other parts of Britain.

One of the great unknowns in science today is how much biological diversity there is on Earth. We have knowledge of and have put scientific names on maybe 1.8 million species of plants and animals, and micro-organisms to date. But that may represent, especially when we thrown in micro-organisms and small creatures - insects, small invertebrates - only about 10 per cent of all the species on Earth. We've only begun to explore this planet.

E.O. WILSON

one of the great unknowns in science today is how much biological diversity there is on Earth

Given that we don't know how many species there are, we certainly can't tell you how many species are going extinct each year.

Another way of putting our lack of knowledge is to say recent, very careful catalogues suggest that about one in five of all mammal species is under extinction threat, but only 3 per cent of fish, and by this assessment, only 6 in every 10,000 invertebrate species.

But if you put that a different way and ask what fraction of the species that have been evaluated for extinction threat, it's roughly the same for mammals - 23 per cent rather than

20. For fish, it's more than a quarter rather than 3 per cent. And for insects, it's a whopping more than two thirds of all species that have been evaluated for extinction threat. That says a lot about what we know, as distinct from what is. Given all those uncertainties, however, we can make a much more precise estimate of the rate of extinction if we assume that the well-known groups like birds and mammals and some groups of plants, and what's happened to them over the last century, are typical. And on that basis, about one bird or mammal species a year has gone extinct over the last century, from a group of species that are of the general order of 14,000 species.

That kind of rate, if it holds for the much larger number of insects and other creatures we don't know much about, is characteristic of the acceleration in extinction rates - above the 'background' [rate] in the half-billion sweep of the fossil record - that characterizes the big five mass extinction episodes like the one that did in the dinosaurs.

ROBERT MAY

Is it worth trying to save species from extinction?

There can be lots of economic reasons that someone could think of why you wouldn't want to put an extraordinary amount of money and effort into saving one animal that is on the edge of its range - the Amur leopard, for example, a small-range, critically endangered species.

My personal belief is that it is morally bankrupt to give up on things that we know are going extinct. It's one thing to talk about some animal dying, but quite another to talk about the end of life - the end of a unique life form that has taken millions and millions of years of evolution to bring to this point - that we have the ability to do something about.

It's almost overwhelming to imagine what future generations will think of us if we don't even try.

So for me, when you talk about saving critically endangered species, the argument is nearly always a moral one. It comes from a moral belief that there is room on this planet for all of these things.

M. SANJAYAN

Another reason for keeping each single one is that every species is a masterpiece of evolution. Every time biologists settle down and study a particular beetle or scorpion or butterfly or tree that might be rare and obscure, they find that they're looking at a history that goes back on average hundreds of thousands to millions of years. It's a product of the unsparing pressure of the environment, moulding that species by adaptation through natural selection. So it has an immensely complicated history.

every species is a masterpiece of evolution ... a history that goes back on average hundreds of thousands to millions of years

When the American chestnut became largely extinct at the turn of the last century from an introduced fungus, that wiped out as much as a fifth or more of the American forest. The forest recovered without the chestnut, but at least seven moth species that lived in the tree went extinct with it.

Well, one of those might not seem very significant to the average person just reading about it, but each one of those moths contained enough genetic history and uniqueness to fill all volumes of the *Encyclopaedia Britannica* published since the 1700s and is a product of the history of this Earth that we should not erase carelessly.

E.O. WILSON

I think any extinction that is before its time matters. But if one was to pick two groups, it's at the very top and the very bottom - the anonymous organisms that keep the planet going and the big organisms that keep our souls and imaginations on fire.

RICHARD MABEY

On the one hand, there are real uncertainties about what will be the consequences for humanity of the great wave of extinctions that are going to unfold over the coming several centuries, well beyond the horizon of a single human lifetime. On the other hand, we need to be doing things now, and to do that, we have to engage many, many, many individuals, which involves appealing to the things that have emotional resonance. Anita Desai once said of the novelist V.S. Naipaul: 'He looks upon the world with an icy clarity beyond regret or hope.' Now, somehow, what we've got to do is balance this clarity of appreciation of the problem, but it has got to be not beyond regret and hope, and has to mobilize the emotions and the caring instincts of people. And so many of these things are a juxtaposition of trying to see the facts clearly but at the same time working with what will work. And hence I see it as entirely correct to be using the panda to represent the host of unknown insects which may be more important.

In the ideal world, given that we are going to lose species, I and others would like us to take a more analytic view when we try to evaluate what will preserve the greatest amount of independent evolutionary history of life on Earth, which would put much more emphasis on the invertebrates, less on the pretty plants and the charismatic megafauna. But in reality, you've got to work with what people can relate to - a mixture of heart and head.

ROBERT MAY

in reality, you've got to work with what people can relate to - a mixture of heart and head

We should worry about extinctions at multiple levels. One has to be concerned about forever - about losing an entire species for all time. And that's a loss not only at a moral, spiritual level, but it's also a loss at a practical level. Each of these creatures plays a role in its ecosystem. If you think in terms of a brick wall, we are systematically knocking out bricks, and sooner or later the wall will collapse.

JAMES P. LEAPE

if you think in terms of a brick wall, we are systematically knocking out bricks, and sooner or later the wall will collapse

One estimate made in 1997 by economists and biologists was that the services provided to humanity - scot-free incidentally - by all those bugs and weeds and possibly seemingly disposable birds and the like was about \$30 trillion. Now that's roughly equal to humanity's own productivity. But in holding water in the watersheds, filtering it and purifying it, pollination, cleansing the atmosphere, restoring soil and on and on through the other ecosystem services, we are getting an immense amount of value from wild creatures left alive, and the more of them there are, the better the job is done.

It doesn't matter what the species is. It can be a bird of paradise. It might be one of my favourite animals, a Sumatran rhino, which is receiving hundreds of thousands of dollars of help to see it through and avoid extinction. But it also can be an obscure moth somewhere. Incidentally, we're not going to be spending a million dollars on this species and then a million dollars on that species, it's not that simple, and it's far better than that image projects.

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Generally speaking, what we spot are places where there are large numbers of endangered species together. So to save one typically means you save them all, or a large part of them. This is the basis of the hotspot concept of conservation, and we now have several dozen of them identified for global conservation efforts.

Hotspots include the rainforests of West Africa, the mountain forest of East Africa, the great floral region of South Africa, the Mediterranean coast, the Western Ghats of India, the sagebrush of southwestern Australia, the transfrontier forest running down the mountain spine of South America, the Atlantic forest of eastern Brazil, and so on around the world.

These are areas with particular habitats within them that, if we save them all and if we could add some of the core areas of the remaining tropical forest wildernesses - the Congo, the Amazon and New Guinea - then we would save substantially more than half of the known species of plants and animals on Earth.

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As far as we can tell, the kinds of benefits that ecosystems give us depend very much on the way those ecosystems function. And that in turn depends on having all the pieces, so that the ecosystems work as a well-oiled machine.

If we start losing some of the pieces, like soil micro-organisms, we're going to lose the productivity of the soil and therefore the productivity of the crops upon which we depend. If we lose large carnivores, ecosystems become