



## CTA-041-Mass Extinction-Earth

Join us to save coral reefs

Vic Ferguson

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### Endangered species

The Observer

# The Earth stands on the brink of its sixth mass extinction and the fault is ours

The rate at which vertebrate species are dying far exceeds the norm

The marine Tylosaurus and the flying Pteranodon died out in the Cretaceous-Tertiary extinction.

Photograph: Arthur Dorety/Corbis Jan Zalasiewicz

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*Life on Earth is in trouble.* That much we know. But how bad have things become – and how fast are events moving? How soon, indeed, before the Earth's biological treasures are trashed, in what will be the sixth great mass extinction event? This is what Gerardo Caballos of the National Autonomous University of Mexico and his colleagues have assessed, [in a paper that came out on Friday](#).

These are extraordinarily difficult questions. There are many millions of species, many elusive and rare, and inhabiting remote and dangerous places. There are too few skilled biologists in the field to keep track of them all. Demonstrating beyond reasonable doubt that any single species is extinct is arduous and painstaking (think how long it took to show – to most people, at least – that Loch Ness probably does not harbor a large monster).

And it's not just a case of making a head-count of modern extinctions. This needs to be compared with a long-term "baseline" rate of extinctions in our planet's long geological history. This can only be extracted via the equally painstaking and difficult work of excavating and identifying millions of fossils from the almost endless rock strata. Not surprisingly, different studies made so far on different fossils have yielded different baseline rates.



**Humans creating sixth great extinction of animal species, say scientists**

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Caballos and colleagues have thought through these difficulties, and come up with probably the most robust estimate yet of how severe the modern crisis is.

They have been deliberately conservative – they're well aware of the dangers of crying wolf on a topic of such importance, and where passions run so high. For a start, they limit themselves to the best-studied group of organisms, the vertebrates. Then, they take a high estimate of background extinctions to compare with, to make the modern figures as undramatic as possible. And



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then, they either consider only those animals known to be extinct (the “highly conservative” scenario), or they add in those extinctions in the wild that are likely to have happened, but are not yet verified.

Even with this caution, the figures are still shocking. Rather than the nine extinctions among vertebrates that would be expected to have occurred in normal geological circumstances since 1900, their conservative estimate adds in another 468 extinctions, spread among mammals, birds, reptiles, amphibians and fish. Examples of lost species would include the [Yangtze dolphin](#) and the [Costa Rica golden toad](#). Depending on the group, extinction rates are 10 times to more than 100 times higher than normal. A sixth mass extinction, therefore, is beginning. They estimate that it would grow to rival the last great catastrophe of the past, when the dinosaurs and much else died out 65m years ago, in as little as three human lifetimes.

Once more, this is a conservative estimate. It simply considers the kill mechanisms operating today, of habitat loss, predation, pollution and so on. The Caballos projection does not try to factor in, for instance, the effects of global warming, or of ocean acidification. Once these kick in earnest, they will sweep many species out of their habitability zones, and ratchet up the extinction rate still further.

In terms of scale, we are now living through one of those brief, rare episodes in Earth history when the biological framework of life is dismantled. It is in every sense a tragedy – but, in itself, it might be viewed as just one more episode of biological destruction in our planet’s history. The Earth has been here before – and will be here again, before its life is completely extinguished a billion or so years into the future.

This particular perturbation to the biosphere, though, has some very special features. Indeed, there has been nothing remotely like it in our planet’s history. By coincidence, one of the authors of the Caballos study, Anthony Barnosky of the University of California at Berkeley, was involved in another study published the same week, a study that sought to put its finger on exactly what is so different – and so weird, in planetary terms, not to put too fine a point on it – about what is happening to the biosphere right now.

This second study, led by Mark Williams, a palaeontologist at the University of Leicester, identified some quite extraordinary novelties at the heart of current events. First, past extinctions have been driven by what are now becoming very familiar horsemen of a planetary apocalypse: massive volcanic outbursts to choke the atmosphere and poison the seas; the mayhem caused by major asteroid impact; and the wrenching effects of rapid climate change. None of these has really figured in the current biological crisis – not even climate change, which is still only in its early stages.

Instead, the extinctions are being driven by the effects of just one single species, *Homo sapiens*. Such a mass extinction has not occurred before (with the possible exception, 2.5bn years ago, when a type of microbe evolved photosynthesis to spew out oxygen, a gas that would have been highly toxic to the other microbes living then, and these would have been pushed to the fringes of life on Earth – where they still remain). Even more extraordinarily, this single species is land-living, but has managed to become the top predator in the oceans too, causing populations of whales and fish to collapse.

In all, our single species now commandeers somewhere between 25% and 40% of primary productivity on Earth. It is a productivity, that over large areas of land, is “hyper-fertilised” by the extraction of millions of tons of nitrogen from the air, in the [Haber-Bosch process](#), and by digging comparable amounts of phosphate from the ground.

These super-fed crops are fed, highly efficiently, to farm animals, that we eat in turn. The scale of this operation is a large reason for the scale of the ongoing mass extinction of other organisms.



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The scientist Vaclav Smil, of the University of Manitoba, has calculated that simply measured by mass, humans now make up a third of land vertebrates, and the animals that we keep to eat – cows, pigs, sheep and so on – make up most of the other two thirds. All the wild animals – elephants, giraffes, tigers and so on – are now less than 5% by mass. It's a measure of how they have been pushed to the fringes by humans.

Humans change things in other ways – they now direct the evolution of the animals that are useful to them, by breeding and by genetic engineering: again, it's a planetary novelty. The energy our species obtains from photosynthesis is not enough, and so we mine stored photosynthetic energy from the ground, as hydrocarbons, in enormous amounts, and use that to power our machines.

These machines – cars, planes, computers and much else – have, together with their human software, been termed the technosphere by the geologist Peter Haff of Duke University. He views it as an emergent system with its own internal dynamics (and which humans currently drive but don't really control) – in effect an offshoot of the biosphere. Whatever it is, it is evolving at lightning speed by comparison with biological evolution.

The changes to the Earth's biology do, therefore, include a rapidly developing mass extinction event, as charted by Gerardo Caballos and his colleagues.

But this may be seen as part of a much more thoroughgoing transformation. Fundamental new patterns are emerging that may be compared, say, with the change, half a billion years ago, when a biosphere consisting only of microbes gave way to one dominated by multicellular animals.

Could this new planetary pattern develop – perhaps well enough to help prevent a mass extinction? Currently, the technosphere is more a parasite than a partner of the biosphere – it is terrible at recycling, for instance.

But some aspects might help alleviate the worst effects of global warming. For instance, humans have caused the greatest transmigration of species in history. Some of these invasive species may be well adapted to new higher temperatures. And better use of energy and materials can reduce pressure on remaining natural ecosystems.

Averting a mass extinction is still possible – but we don't have much time.

*The author is professor of palaeobiology at Leicester University*

## Exegesis of Pope Francis's encyclical call for action on climate change

**Letters:** Pope Francis's encyclical introduces two terms buried by modern economics: 'need' and 'greed'. These represent two opposing worldviews

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### **NOT THE FIRST TIME**

#### **Previous mass extinctions**

Geological history includes many periods when species have died in large numbers. In each of the following, more than half the Earth's species disappeared:

##### **1 End-Ordovician, 443 million years ago.**

This coincides with very rapid glaciation; sea level fell by more than 100 metres, devastating shallow marine ecosystems; less than a million years later, there was a second wave of extinctions as ice melted, sea level rose rapidly, and oceans became oxygen-depleted.

##### **2 Late Devonian, c 360 million years ago.**

A messy prolonged event, again hitting life in shallow seas very hard, and an extinction that was probably due to climate change.

##### **3 Permian-Triassic mass extinction, c 250 million years ago.**

The greatest of all, 'The Great Dying' of more than 95% of species, is strongly linked with massive volcanic eruptions in Siberia that caused, among other effects, a brief savage episode of global warming.

##### **4 Triassic-Jurassic mass extinction, c 200 million years ago.**

This has been linked with another huge outburst of volcanism.

##### **5 Cretaceous-Tertiary mass extinction 65 million years ago.**

This killed off the dinosaurs and much else; an asteroid impact on Mexico probably did the damage, but the world's ecosystem may have been weakened by volcanic outbursts in what is now India.



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*The only thing necessary for the triumph of evil is that good men do nothing" ...**Edmund Burke***