



The world's vanishing wild places are vital for saving species

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Cheetahs have extraordinarily low genetic diversity, placing them at risk. Copyright Amy Nichole Harris/Shutterstock

In science, it's rare that a new idea comes along that stops people in their tracks. For ecologists, this has just happened, in a paper that found that species living in wild places have more genetic diversity than the same species living in areas dominated by people.

Why is this big news? For starters, it's a completely new reason to worry about the decline of wilderness.

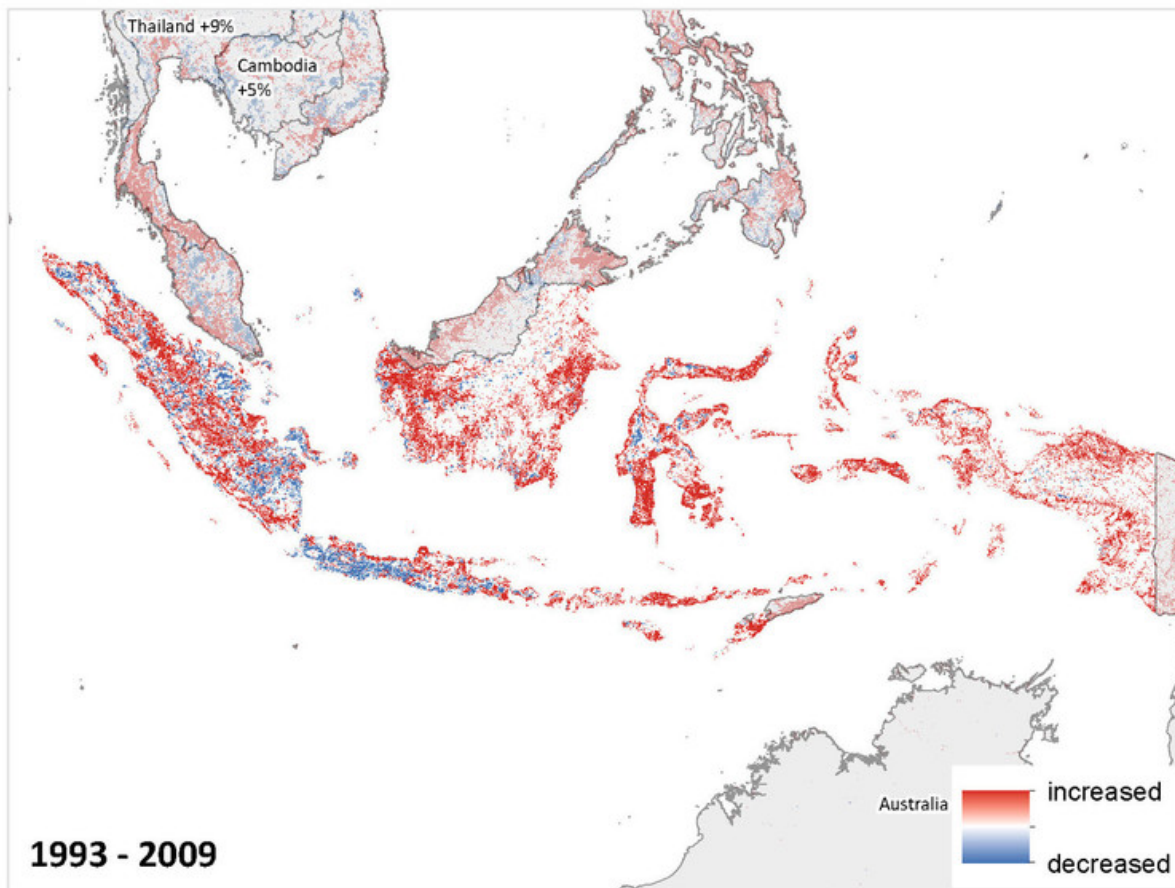
My colleagues and I showed recently that wilderness areas have shrunk by a tenth globally in just the past two decades. Large wild areas are now mostly confined to cold, dry or otherwise inhospitable parts of the planet such as the far north and big deserts. Biologically rich rainforests have been destroyed the fastest.

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In Southeast Asia, as elsewhere, human activities are expanding while wilderness areas are shrinking. Shown here are changes in the Human Footprint over the past two decades. O. Venter et al. (2016) Scientific Data

The traditional reasons for defending wilderness areas are that they store massive stocks of carbon, produce clean drinking water, limit destructive flooding, harbour countless rare species, generate billions of dollars for local communities via ecotourism, and provide a scientific basis for understanding how nature is supposed to function in a rapidly changing world. These are compelling enough.

But this new finding is a game-changer, because it shows that genetic variation, the raw fuel for evolution, relies on wilderness too.

Environmental armageddon

The history of life on Earth has been a lot like what soldiers experience in a war: long periods of relative stability and even boredom punctuated by sudden periods of stark terror. Right now, we are living in one of the scariest times since life arose at least 3.7 billion years ago.

Life on Earth today is being battered by massive habitat disruption, climate change, invasive species, foreign pathogens, pollution, overhunting, species extinctions and the disruption of entire ecological communities. And it's all down to humankind, which currently dominates three-quarters of the planet, according to our recent estimate.

Faced with this environmental onslaught, which will surely worsen in the coming century as the Earth struggles to support up to 12 billion people, the options for species are frighteningly limited.

Change or die

As Charles Darwin argued more than a century ago, hidden within most species is a surprisingly large amount of genetic variation. Humans vary in height, weight, body shape, skin colour, physiology and biochemistry.

Wolves, first domesticated around 40,000 years ago, have since been bred into dog varieties ranging from tiny Pekinese to Great Danes.



The world's hugely varied breeds of domestic dog all arose from a single species of wolf. Shutterstock

For most organisms (except simple bacteria and other organisms that reproduce by cloning), there are two main sources of genetic variation: mutations and sex.

If life were a card game, then mutations create new cards. Most mutations are bad for the individual – such as those that cause the bleeding disease **Haemophilia A** – or are more or less neutral. But now and then a mutation generates a highly beneficial wild card.

While mutations create new cards, sex shuffles the deck, mixing our genes into new combinations. That's important too, because by doing so one can discard bad cards. Individuals with bad cards tend to die or fail to reproduce, removing their dud genes from the population. And every once in a while a really good combination of genes pops up, like a Royal Flush, that can then spread rapidly through the population.

The ability of species to change and adapt, or evolve, is vital. We tend to think of evolution as an incremental process, requiring thousands or millions of years, but that's not always so. When things get rough, species with lots of genetic variation can evolve surprisingly fast.

Evolution in action

Consider what happened when scientists introduced **myxomatosis** to Australia in 1950 to kill off introduced European rabbits, which were stripping the continent's vegetation bare. At first, most of the rabbits died. But a few, which by random chance were more resistant to the pathogen, survived and reproduced. Within a few decades rabbits had evolved a far greater capacity to resist the disease.

And just as remarkably, myxomatosis evolved as well. It became less deadly. If you're a pathogen, you don't want to kill your host straight away because then you'll die too.

Instead, you just want to make your host sick, or kill it very slowly. That way, you can spread to lots of other hosts. So while rabbits became more resistant, myxomatosis also became less virulent. And it all happened in just a couple of decades.

Something similar is happening with Tasmanian devils, which are being killed off by a bizarre contagious cancer that spreads when the notoriously scrappy marsupials fight with one another.

Recent studies show that genes which produce greater resistance to the cancer are rapidly increasing in the population. Unfortunately, the devils don't have a lot of genetic variation but hopefully they'll have enough variation remaining to get past the killer cancer.



A Tasmanian Devil suffering from facial tumour disease, a contagious cancer. Menna Jones

Things are even scarier for the cheetah, the world's fastest land animal. While built for speed on the African plains, cheetahs will have a hard time outrunning new environmental challenges. That's because they have almost zero genetic variation.

Roughly 12,000 years ago, cheetahs went through a severe population bottleneck, eroding most of their genetic variation. The species is paying a price for this today, with reduced sperm quality, kinked tails, and palate deformities among other problems. These maladies arise both from low genetic variation and from inbreeding, which occurs because individual cheetahs are so similar genetically.

Sadly, this could make Cheetahs perilously vulnerable to an "extinction vortex". The vortex starts with a population crash, perhaps from a newly-introduced disease, habitat loss or climate change. The remaining individuals are already so severely inbred and depleted of genetic variation that they reproduce and survive poorly. Their population dwindles and crashes into oblivion.

We need wilderness

That is why the new study is so significant: it shows that a particular species living in a wild area has more genetic variation than does the same species living in a place where humans abound. The study was based on over 4,500 different species of amphibians and mammals scattered across the planet and was published in one of the world's best scientific journals. This gives us a lot of confidence in the strength of its conclusions.

The bottom line is that the world's wilderness areas are under assault. We are not just losing wild places with clean air and water and beautiful vistas. We are losing the raw fuel of evolution and adaptation that has taken life millions of years to accumulate.

Given the breakneck pace at which we are currently changing the planet, eroding the capacity of species to adapt to new challenges is absolutely the last thing we want to be doing.



The sun sets over the wilds of the Western Ghats in southern India. William Laurance

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