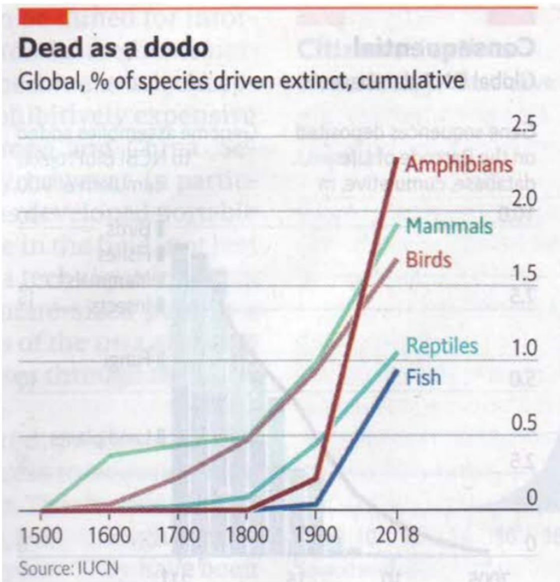
The other environmental emergency

(Biodiversity in danger)

Although the biodiversity crisis has a fraction of the public profile, it poses as great a risk to human societies as climate change. Since the 1990s, studies show how rapidly animal and plant species have been declining all around the globe, thus ecologists have long been talking of an impending mass extinction. This would not be the first time, however, uniquely in Earth's history, the drivers of this ecological change (climate change, pollution, exploitation of land, sea, plants, and animals) is caused by one single species: homo sapiens. According to the 2020 Living Planet Report, produced by the WWF and the Zoological Society of London, human activity is thought to be causing species to disappear nearly 100 times faster than the natural background rate.



In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published its assessment of the state of global biodiversity, which offered a very alarming picture. It found that roughly one million animal and plant species, including many that are used in farming, were at risk of extinction, more than at any other point in human history. By 2016, no less than 9% of domesticated mammals had become extinct. As of today, more than one-third of continental land area and nearly three-quarters of freshwater resources are used to produce crops or livestock, but environmental degradation has severely damaged these places' ability to support these activities. In addition, one-third of marine fish stocks were being unsustainably exploited in 2015.

The new web of life

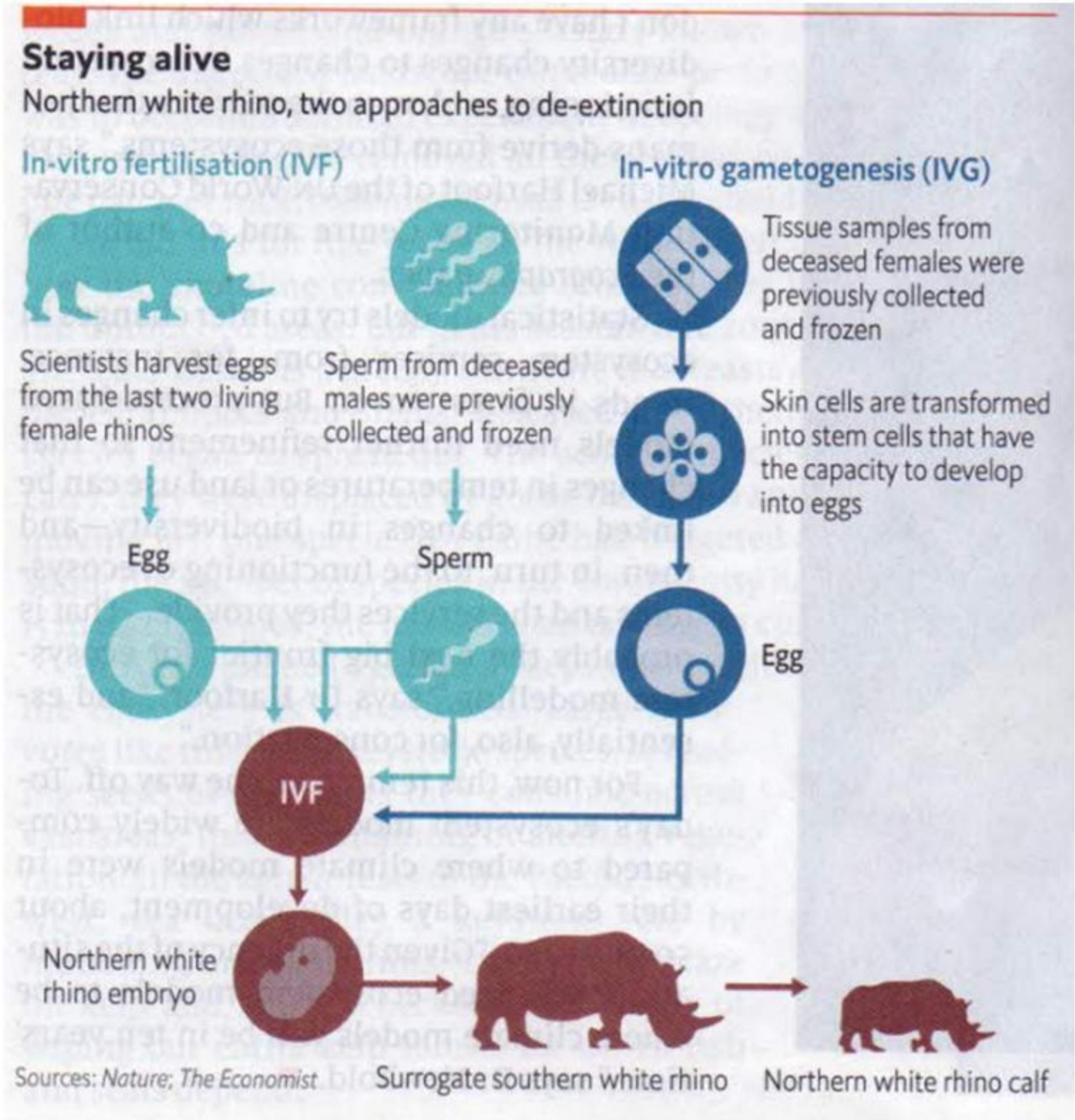
In the past decade, an explosion in the use of sensors to monitor ecosystems has occurred. These devices, such as the AudioMoth or TrailGuard, were invented to not only record environmental data but also to monitor the nature, number, and movement of living things. To do so, they are now peppered across forests and national parks or attached to trees and the backs of animals. In scanning through the resulting sound recordings, images, and other readings, machine learning has an important role and big tech firms, including Google and Microsoft, are also getting involved. Google for example has helped to create Wildlife Insight, which is creating a single space where all camera traps could log their data in the future. Monitoring ecosystems is also done from the air or space by dozens of Earth-observation instruments. These are able to collect information about land use, monitor deforestation rates in remote regions, or detect blooms in oceanic plankton. However, satellite imagery can be easily flawed. To assess forests' health better and to map out spaces in high resolution and three-dimension LIDAR became the most important technique, which employs infrared laser light instead of radio waves. Combined with spectrometers, The Global Airborne Observatory created detailed pictures of landscape showing the shape, size, and species of individual trees, from which the carbon content and overall health of the observed forest could be determined. Due to this technique's success, a related tool was launched that is focusing on the oceans. The Allen Coral Atlas combines high-resolution satellite imagery with machine learning to monitor coral bleaching events in real-time, identifying bleaching that previous surveys had missed.

Cracking the code

Besides these kinds of scanning and sensing technologies, since the 1980s, the sampling and sequencing of genetic material have emerged as a powerful conservation tool. Gathering and sequencing the DNA of animals was found favour with researchers studying freshwater systems because it allows them to find out if a target species is being present or even how abundant it is by simply dipping a test tube into a stream. DNA from scat can map out food chains without capturing or killing animals to examine the contents of their guts. Additionally, eDNA studies allow researchers to detect rare species, spot invasive ones and see how populations interact with each other. Although the field is booming, there are still many challenges. Most importantly, species identification is only as good as the species-specific genetic barcodes and reference genomes that serve as points of comparison. Therefore, the Earth Biogenome Project aims to sequence 1.5 million species in the next ten years. The other problem is its price: genetic sequencing remains prohibitively expensive for most researchers outside Europe, America, and China. To make this technology more available, Oxford Nanopore, a British company, has developed MinION which is a relatively affordable, USB-powered, pocket-sized device capable of doing every part of the sequencing process in the field. Such a device was used to sequence bacteria on the International Space Station. A paper published in Forensic Science International: Genetics earlier this year found that this technology is potentially paving the way for handheld devices to be used in wildlife-crime prosecutions as well.

Other genetic and reproductive technologies developed in the last ten years might make it possible to create live newborns long after the last members of its species have gone extinct. In 2009, a team of researchers announced that injecting DNA from the last female bucardo into the emptied eggs of a domestic goat led to one live birth. Although the bucardo lived for only a few minutes, this technique paved the way for other discoveries. In 2016, Katsuhiko Hayashi, a reproductive biologist, and his team created baby mice from skin cells and sperm. And since 2018, the BioRescue team has been working tirelessly on embryo transfers to bring the northern white rhino back from its "functionally extinct" status. Efforts to make this a viable option for rescuing species from the brink of extinction must begin way before it is reduced to a very limited number of individuals. Frozen collections at the San Diego Wildlife Biodiversity Bank contain more than 10,000 cell lines belonging to 1,100 species and subspecies. Even if reviving extinct species does not become possible soon, these biobanks can still be used to improve genetic diversity in endangered species, which is essential for their survival.

De-extinction – Back from the dead



The wisdom of crowds

Apart from these new complex techniques, ecology is long been helped by some more humble players: enthusiastic citizens. For decades, bird watchers have contributed precious data about population size, trends, behaviour, and migration by sending their recorded sightings to bird protection societies. Today, social networks and mobile applications providing extensive data for researchers: eBird, for example, marked its billionth observation in May. This free application was created by the Cornell Lab of Ornithology in New York and allows the public to upload pictures and recordings of birds labeled by time, location, and other criteria. Another success story is iNaturalist, a social network run jointly by the California Academy of Science and the National Geographic Society. So far, its 4 million users have contributed 66 million observations of over 300.000 species. All this data is used to generate detailed maps of species distribution and snapshots of how populations are changing and adapting to their environment.

Ecosystem modelling

Ecology has only a few equivalents to climate change models. It is largely because ecosystems, and the interactions between the living things, are harder to simulate than the global climate. The loss of biodiversity cannot be quantified into parts per million of carbon dioxide or degrees above pre-industrial average temperatures. Therefore, ecosystem modelling is still in its infancy. Although there are existing statistical models, they are unable to capture or predict the dynamic, non-linear ways ecosystems respond to change. Using the same idea as climate modelling, standardised scenarios regarding marine ecosystems can be developed through "Fish-MIP" to inform policy decisions. However, simulations of the effects of fishing operations (that are leading to overfishing) or other ways in which humans affect biodiversity are largely based on assumptions. And modelling for land ecosystems is even far less advanced, although changing landscapes, particularly through agriculture, is likely to have an increased impact on biodiversity. Expanding agricultural activities results in reduced plant life at the base of food webs, which poses a great threat to entire food chains. Through simulations, Tim Newbold and his colleagues at University College London found that once 80% of plant life is gone, entire food chains begin to collapse without the possibility of rebuilding them by simply restoring the plants.

The role of policy

Among others, clean water, clean air, and carbon storage are all examples of "ecosystem services" that benefit humanity. However, by causing important species to disappear "We are eroding the very foundations of our economies, livelihoods, food security, health and quality of life worldwide" said Sir Robert Watson, chairman of IPBES. Although protecting the biological, ecological, and genetic diversity that sustains life on Earth is the mission of the United Nations Convention on Biological Diversity, not one of its 20 conservation goals for 2020 was met fully. To meet these targets, technologies can only help conserve biodiversity in conjunction with policy changes and this will require three things. First, the various monitoring systems must be knitted together to provide a clear picture of the current situation and what needs to be done. The second step should be creating more powerful and detailed ecosystem models to help policymakers set more specific and quantifiable targets and clear methods for measuring success, as already exist for climate change. Once models, monitoring systems, and policies are in place, technologies can be applied to assess, enforce or if needed, improve those policies. All this requires considerable funding, but it cannot be only focused on rich countries.

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