Appreciating biodiversity science: Why biodiversity should be a big science

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Professor F. Guillaume Blanchet from Université de Sherbrooke posits the importance of treating biodiversity science as a big science to reach the goals set during the COP15 on biodiversity

Biodiversity encompasses every variety of life on Earth, from the bacteria that cause strep throat to blue whales and humans. Biodiversity has been studied everywhere, from seemingly alien ecosystems around hydrothermal vents at the bottom of the oceans to the mosses and lichen of Mount Everest. Biodiversity should not only be seen as the number of species that live in a particular area at a specific time but also understood as how living organisms differ in their genetics and functions and how ecosystems differ from each other.

How biodiversity benefits humanity

Biodiversity has provided humanity with crops, animals, medicines, and various products we use daily. For example, almost all the food humans consume comes directly from plants and animals. Similarly, some of the most efficient pharmaceutical products are directly derived from nature; Penicillin was initially derived from the mold Penicillium rubens. Biodiversity has also served as inspiration for our global cultural heritage (religions, songs, movies, arts, cuisine, etc.) and is a source of relaxation, beauty, and peace.

Given the immense resources biodiversity constantly provides humanity, we know surprisingly little of what lives on Earth. We are still regularly discovering new species, not only cryptic species of insects, bacteria, or fungi but also large vertebrates like snakes, fish, and mammals. Of the organisms we have identified, we often know very little about where they live, when, how, and where they reproduce.

This is true for scarcely studied groups of organisms such as mosses, worms, invertebrates, as well as charismatic groups of species like birds and mammals.

For example, birds are the most recorded group of organisms, mainly because of people's huge interest in them. To record bird sightings from scientists and the public alike, computer infrastructure like eBird has been implemented to make the data available for ecological research. Yet, there is a large knowledge gap in the number and types of bird species found in areas covering millions of square kilometers in Canada, Russia, China, and inland Africa.

With the impact of human activities on biodiversity (including climate change, deforestation, or urbanization) and the recent interest in world governments to take action and protect biodiversity (namely the 15th UN Conference of Parties (COP15) on biodiversity), biodiversity science is unprepared to propose solutions to problems such as defining which 30% of the globe should be protected by 2030 (Target 2 of the convention on biological diversity) to name but one. As such, we need a paradigm shift to move biodiversity science forward and reach the world governments' goal to better protect biodiversity.

The big science of biodiversity

Big science usually implies large budgets and large teams of scientists who work in synergy towards a common goal. It is also common for big science to require unique technology, so it often centralizes scientific research.

The Manhattan Project, the Human Genome Project, the Large Hadron Collider, and the International Space Station are all the results of big science. Given the importance of biodiversity for humanity, biodiversity science must become a big science if we want to reach the goals set during the COP15 on biodiversity.

To move biodiversity science forward, the first step is to describe and monitor the organisms living on Earth to know where they are and how their distribution changes through time. Recent technological advances are helping achieve this goal with nano-sequencers that can help identify new species and environmental DNA, LiDAR, and satellite imaging that can help locate where they are on Earth. However, new technologies are required to know more precisely where organisms live, especially in oceans, lakes, and rivers. As mentioned above, Target 2 of the Convention on Biological Diversity requires that 30% of the Earth be protected for biodiversity. Yet, we still have very scarce knowledge of what is on Earth and where it lives. We need to gather much more biodiversity data, and it needs to be done systematically.

Describing what lives on Earth is only the first step. To ensure adequate protection and management of these organisms, it's essential to understand their habitats. These questions require intense data processing, often with advanced statistical and mathematical models and Artificial Intelligence. However, the complexity of the biological and ecological systems makes this task extremely challenging. Scientists need to develop new, more efficient models to better understand why some species are found in some locations but not others.

To efficiently protect and manage biodiversity, especially with climate change, we must predict how biodiversity will change across space and time. This is a particularly challenging task. To accurately predict where and when biodiversity changes will occur, we also need a good idea of how the environment will change. Although climate research has taken huge strides in getting better climate predictions, the uncertainty of climate models combined with the uncertainty of biodiversity data makes it highly challenging to obtain good predictions of what biodiversity will look like to make enlightened predictions on how to protect it, even in the short term (e.g., 2030).

Governments and scientists must treat biodiversity sciences as a big science to meet the various targets set to safeguard biodiversity as per the latest COP15 on biodiversity. This is imperative to ensure that our future generations have a planet as habitable as the one we inherited.

Want to know more?

Prof. Paul Hebert gave a talk at the GEOBON conference in Montréal (Québec, Canada) in 2023, discussing the basic ideas highlighted in this article. It is available here.

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