

## **Saving Nature with Natural History Museums?**

Julia Krohmer, Volker Mosbrugger  
Senckenberg Gesellschaft für Naturforschung (SGN),  
Senckenberganlage 25, 60325 Frankfurt, Germany  
e-mail: jkrohmer@senckenberg.de

Natural history museums (or nature museums) today are more important than ever. They are places that bring people together, to learn about nature, its history and functioning, to build an emotional relationship with nature and to marvel about the treasures and wonders of life on earth. They make us understand the importance of nature.

But their role is even more important.

Nature museums' collections are archives of the past, they contain specimens from millions or even billions of years back in time. They allow us to shed light on fundamental processes like evolution, climate change or ecosystem functioning. The curators and scientists use the collections to conduct up-to-date research that is essential to understand the earth system, the history of species, the role of man in nature, and the dynamics of interactions between mankind and planet earth.

The particular power and potential of nature museums, compared to universities and other "normal" research institutions, is that they also create bridges and linkages between disciplines, which today are often highly specialized. Despite the giant progress achieved by specialization, the reunion of the disciplines and a holistic system view are now required, as complex systems cannot be understood with isolated approaches. At Senckenberg, we call it "Geobiodiversity research – Analyzing Biodiversity in Earth System Dynamics to Serve Science and Society".

This holistic approach is not only needed for research, but also for education and training in schools or universities. It enables society to deal with today's major challenges, like climate change, biodiversity loss, landuse change, resource exploitation, energy supply, health, etc. Transdisciplinary research overcomes disciplinary boundaries and involves as well non-scientific stakeholders, to develop systemic, realistic approaches to address these challenges.

Here we come full circle: Nature museums are not only research platforms, but ideal places for this transdisciplinary interaction and dialogue: They are trusted and respected, impartial institutions, seen as honest brokers, and thus will play an important role in pooling academic communities, politics, NGOs, the business community and other societal actors to solve the sustainability crisis.

Paying attention to natural history and conserving nature museums thus contributes to understanding and sustaining the present, and to supporting the future: the future of life on earth, and the future of life on earth with us.

Key words: Nature museums, earth system, sustainability, geobiodiversity

### 1. INTRODUCTION: "NATURE IS OVER"

This was the alarming statement of Bryan Walsh, published 2012 in the Times Magazine [1], who concluded that mankind is exerting such a strong influence on nature, everywhere around the globe, in all ecosystems, that it actually cannot be called „nature“ anymore.

Already 10 years earlier, in 2002, the Nobel Prize winner Paul Crutzen published a short paper in *Nature*: "The Geology of Mankind" [2]. His argumentation: Science and technology decoded and changed the construction pattern of nature in a way that mankind now has to be considered as a "quasi-geological force". The earth is no longer in the geological era of the holocene but in the "anthropocene". We are at the beginning of a new area. And it's a frightening one – we are facing giant problems.

Ecosystem services (all the provisioning and values of nature supporting our life on planet earth) worth about 125 trillion \$ per year are at risk. Hundreds of millions of people are already, or will be, leaving their homes, potential environmental refugees searching for better environmental conditions in other regions of the

world. Displacement linked to climate change or to environmental degradation is not a future hypothesis – it’s a current reality. An annual average of more than 20 million people have been forcibly displaced by weather-related sudden hazards – such as floods, storms, wildfires, extreme temperature – each year since 2008.

For many global decision makers, environmental risks do still play a major role, compared to socio-economic and economic issues. Their linkages to global wellbeing and economic prosperity are often not realized. A comparison of the "Global Risk Reports" from 2008 to 2018 shows that the environmental risks (Fig. 1, green) were suddenly estimated as quite important in 2011 and are, since then, always more or less present in the survey, increasingly in the last few years since 2016 [3].



Fig.1 Top 5 Global Risks in Terms of Likelihood and Impact (Source: World Economic Forum, [3])

The finding, that only since a few years environmental problems are taken into account by the “world leaders” is disturbing for a natural scientist. It demonstrates that until short time ago they considered environmental problems as a largely "subordinate issue", and in some cases also a "luxury" problem – 25 years after the Rio Conference of 1992. And how can it be explained that water and food supply are primarily seen as social issues, and not as environmental problems, although they are directly depending on a healthy and functioning environment, of biodiversity and ecosystem services? Aren’t the "economic risk factors" like the high volatility of energy and food prices ultimately based on the scarcity of the resource "nature"? Why is only the increase in greenhouse gases identified as a relevant environmental problem, while the ongoing mass extinction of species and the issue of land use do not even appear to be among the top 5 of global risks? Obviously, global leaders find it difficult to recognize the systemic connections between nature and societal as well as economic problems, which makes it hard to combat causes instead of symptoms. The challenge of sustainable development is thus truncated, although sustainability is supposed to be precisely the harmony and equality of society, economy AND ecology.

But there is hope: On the website of the Global Economic Forum, it is also commented: "A cluster of interconnected environment-related risks – including extreme weather events, climate change and water crises – has consistently featured among the top-ranked global risks for the past seven editions of The Global Risks Report. Environment-related risks again stand out in this year’s global risk landscape”.

PLANETARY BOUNDARIES

Yet, we are changing nature in a way that is putting at risk our own existence: In an influential article published in Nature 2009 [4] (and updated in 2015, [5]), Rockstrom and colleagues warned that with respect

to several environmental parameters, we are leaving the safe operating space for humanity. According to the authors this is particularly true for climate change, nitrogen cycle and biodiversity loss. The pattern and speed of extinction and extinction threat of species is unprecedented in the history of life.

For other parameters, we don't even know the boundaries yet:

- Ecosystem functioning

- For emissions of toxic and long-lived substances such as synthetic organic pollutants, heavy metal compounds and radioactive materials, we are unable to quantify a single chemical pollution boundary.

If we want to address and solve these problems, we have to be aware that they are linked. What is actually needed is an Earth System Approach, which considers that the various components of the Earth System, including the Anthroposphere, are closely connected and interacting.

How can be explained, that these risks aren't perceived in a stronger way, and more taken into account? What are the patterns of thinking and behavior that persist, often despite a better knowledge? Many reasons are responsible, and I will list only four that seem particularly important.

#### ALIENATION FROM NATURE

More than half of the world's 7.5 billion people live in cities today and are largely alien to nature. This applies in particular to our modern technology societies, their opinion leaders, decision-makers and educational institutions. Since the origins of the genus *Homo*, about 2.5 million years ago, we have successfully deprived ourselves of nature through cultural evolution, becoming independent from natural selection: our survival and propagation chances depend less on our own genes than on the available medical technology and care. There have never been so many people on earth and their average life expectancy has never been that high. We have paid for this progress with a growing alienation from nature. Today, our life "environment" is technically man-made and no longer nature. And the "nature" that we so much like to visit for recreation is not a natural, but an anthropogenic one, a cultured landscape characterized by centuries of human interventions and landuse. So we lost our feeling for nature, we do not know, understand and feel it anymore.

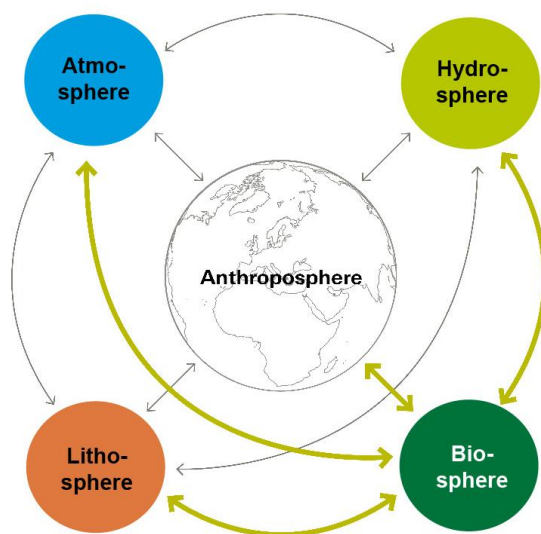
However, we humans are living beings: we are therefore part of nature and depend on it, for resources, such as food or energy, as the increasing environmental disasters continuously remind us. But nature has become a foreign body in our life, which we underestimate in its importance and its controllability. The American journalist and best-seller author Richard Louv [6] rightly speaks of a "nature deficit disorder". Our alienation from nature not only makes us unable to recognize its importance and to manage it in a sustainable way; it also makes us mentally poorer. "The future will belong to the nature-smart – those individuals, families, businesses, and political leaders who develop a deeper understanding of the transformative power of the natural world and who balance the virtual with the real. The more high-tech we become, the more nature we need".

#### OVERESTIMATION OF CAPABILITIES

Due to this alienation from nature, we feel outgrown and superior. The successes of our creativity and our inventor spirit are everywhere – so impressive that we forget, for pride and self-love, our boundaries. The psychoanalyst Horst-Eberhard Richter identified this "God Complex" [7], the delusion, resulting from the "disenchantment" of the churches, to shape, control and heal everything, as one of the big psychological stresses and problems of modern times. The alienation from nature leads to an alienation from our own evolution history and thus to a naive overestimation of our possibilities, at any rate a self-concept which is not appropriate to the reality of evolution.

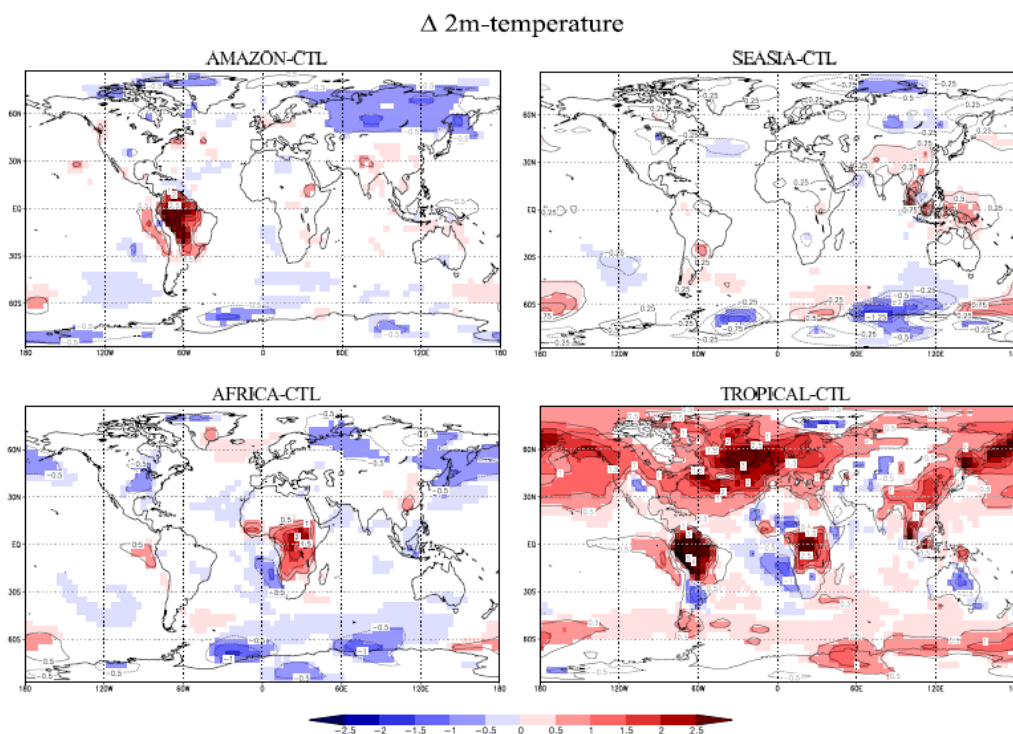
#### COMPLEXITY

On the other hand, we are increasingly aware that our massive interventions in nature entail complex long-term consequences. The destruction of mangrove forests and coastal vegetation will increase the damage caused by the inevitable tsunamis. The burning of fossil fuels generates a growing greenhouse effect with far-reaching consequences for all sectors, from health to forestry and agriculture to the tourism industry. The global deforestation of an area of the size of Great Britain annually results in changes in the water cycle, increasing erosion, biodiversity loss, desertification and soil degradation, thus triggering societal changes and conflicts as can be observed in Latin America and Africa. So it is not surprising that, according to the UNO, there are already more environmental refugees than war refugees.



**Fig.2** The earth system with its components hydrosphere (water, ice), atmosphere (air), lithosphere (rocks, soil and biosphere (living beings)). Green arrows: interactions that Senckenberg is working on.

In fact, we must note that even the best experts do not yet understand the entire complexity of nature processes. Earth is a system of interlinked components such as the hydrosphere, the atmosphere, the biosphere and the geosphere (including soil), and finally, at least since the industrial revolution, the anthroposphere (Fig. 2). Interventions into one sphere, such as the emission of anthropogenic greenhouse gases into the atmosphere, inevitably lead to consequences for all other components of the earth system – but we do hardly overlook them in detail today. A striking example is the increasing deforestation in the tropics. In experiments with modern climate model systems, the climatic effects of deforestation in different parts of the tropics (Amazonia, Africa and Southeast Asia) were analyzed (Fig. 3, [8]).



**Fig.3** Computer models show the expected global cooling and warming effects resulting from deforestation in different tropical regions as well as in all tropical regions simultaneously [8]

Wherever tropical forests are destroyed, this leads to a regional warming at the site of deforestation, but also cools down other parts of the world. Regional interventions therefore have effects in distant parts of the earth, but the effects differ depending on the region. The climatic impact of the deforestation of the entire tropics is bigger than the sum of the effects of the deforestation of the individual regions – this is also a typical system property.

Unfortunately, we deal badly with highly complex systems; we instinctively avoid a careful confrontation and analysis. We prefer to get rid of such problems, shift them (to the next generation, for example) and simplify and diminish them – we all know our defense mechanisms too well. In her very readable book "Collapse or Evolution?" [9], Rebecca Costa identifies our "cognitive threshold" in the handling of highly complex systems and states it as a crucial cause for the collapse of societies like the Mayas. Today, we are confronted with the same challenge to overcome this cognitive threshold.

The dissociation of natural science since the late 19th century into highly specialized disciplines such as zoology, botany, geology, mineralogy, crystallography, etc., is a further consequence of this behavior. Despite the enormous progress achieved by this reductionist strategy, the reunion of the disciplines and a holistic system view are now increasingly in demand. For complex systems cannot be understood with reductionist approaches alone – a system is much more than the sum of its parts. And this holistic approach is needed not only for research, but also for education and training in schools, universities and outside schools. The consideration of nature as a system means that man and his impact must be included. We speak of an earth-human-system, which needs to be understood as a whole. This requires that the persistent separation of natural sciences and engineering sciences on the one hand and the humanities and social sciences on the other must be overcome. Transdisciplinary research and solutions are in demand today; the current major challenges, be it population growth, energy and resource confinement, health, education etc. are transdisciplinary (systemic) nature and cannot be solved in an isolated, disciplinary way.

#### LACK OF COMMON LANGUAGE

We are therefore not only alienated from nature, but with our discipline-oriented, reductionist approach not able to understand the complexity of nature and the earth-human system. With our environmental interventions with drastic impacts mentioned above, we are operating the earth system in blind flight mode – this is irresponsible and has to change in view of our grandchildren's generation. However, this requires not only an innovative, system-oriented research, but also a new kind of education.

In his book "The Two Cultures" [10], Charles P. Snow diagnosed a profound gap and the absence of communication between the classically educated members of society (trained in literature, philosophy etc) and the natural sciences. He stated that the literati, the educated in art and culture, had claimed the concept of "intellectual" for themselves, and thus depreciated and excluded the natural scientists. In a second edition of the book, he calls for the development of a "Third Culture", which would bridge the lack of language between first and second cultures. John Brockman, the influential American literary critic, takes up this concept in his book "The Third Culture - Beyond the Scientific Revolution" [11]. He recommends a "marketing" of those natural scientists who are able to present their scientific concepts in a vivid and exciting way. Like the classic "intellectuals" they will trigger social discourses and influence history: "Unlike previous intellectual pursuits, the achievements of the third culture are not the marginal disputes of a quarrelsome mandarin class: they will affect the lives of everybody on the planet." And: "What we are witnessing is a passing of the torch from one group of thinkers, the traditional literary intellectuals, to a new group, the intellectuals of the emerging third culture" [11].

One may follow Charles P. Snow and John Brockman in these reflections or not – it is true that "education" is still very much related to the humanistic and classical-cultural spheres, and as John Brockman states as well, is it still socially quite normal and tolerated that people seem almost proud of their ignorance concerning natural sciences.

#### HOW CAN NATURE MUSEUMS ADVOCATE FOR NATURE AND THE ENVIRONMENT?

The four problem areas listed above are obstacles to a realistic assessment of the current nature exploitation and the various environmental risks, as well as an obstacle to their sustainable handling. They are not new and certainly not the only ones. However, they show the following: It is not only the lack of expert knowledge that prevents a solution, but a lack of a basic societal understanding of the importance of nature, the role of man in nature, and the dynamics of the earth-human system. What is required is not only more – and more holistic – natural research, but, in particular, more nature education based on **authentic experience of nature**. It must go beyond the standard laws and processes of physics, chemistry and biology, and enable systemic access to nature. First developments in this direction can be seen in schools and

universities, even if the single-disciplinary training canon still dominates. Nature museums can play an important role here as an out-of-school and social learning place.

#### NATURE MUSEUMS PROMOTE THE “LOVE FOR NATURE”

To arouse emotions for nature and to provoke curiosity for more nature is one of the most important tasks of nature museums, they have to appeal to the sensations and the feeling of their visitors. "Customers" are first of all the children, but adults, often influenced by their enthusiastic children, can still be emotionally reached. Thus, nature museums in the modern city societies can and must counteract the increasing alienation from nature. In doing so, especially when it comes to emotions, the auratic experience of an original and authentic specimen may not be replaced by any computer animation. This means, on the other hand, that no visit to a natural museum can replace the experience of "real" nature. But with its immense compaction, however, a nature museum can achieve a particular quality of natural fascination.

#### NATURE MUSEUMS CREATE AN EVOLUTIONARY SELF-CONCEPT

The evolutionary process is one of the core topics of nearly all nature museums, and rightly so. The fossil history shows the course of evolution in "real-time". The diversity of nearly 10,000 species of birds today, with their bizarre shapes and colors, is a product of evolution. The whales as aquatic mammals possess both terrestrial and amphibious ancestors. Humans are as well a product of evolution, and in the last six to seven million years we have – despite our cultural achievements – veered only a little away from our next living relative, the chimpanzees, with whom we share almost 99 % of our DNA. This and many other impressive pieces of evidence for the evolutionary process the visitor will experience in the world's nature museums.

However, the idea of evolution must be thought thoroughly through to the end. As an evolutionary product, *Homo sapiens* is a species like any other of the nearly two million known species, with species-specific characteristics; but this, as every biologist knows, holds for every biological species. Man is therefore only in his own perception something "really special". But isn't precisely this perception unscientific and naive? Isn't our unrestrained drive for growth, our efforts to subdue the earth, a biological heritage that we share with all species? Don't we have to recognize the evolutionary limits of our thinking, feeling, and behaviour, as we easily recognize them in wild animals or our pets?

With their omnipresent evolutionary background, the nature museums can and must help us to see and understand a realistic, evolutionary self-understanding, without anthropocentrism, including the background of biological evolution and our own evolutionary history. The more we approach an evolutionary self-understanding, the sooner we will escape the "god complex" mentioned above, approach a certain humility towards nature and develop an appropriate precaution when using its resources instead of just depleting them.

#### NATURE MUSEUMS OFFER ORIENTATION KNOWLEDGE IN A COMPLEX WORLD

In 1989, the German philosopher Jürgen Mittelstraß wrote in his influential work "Der Flug der Eule" [12]: "In modern society the distance between instrumental knowledge and orientational knowledge is increasing. Instrumental knowledge is knowledge of causes, effects, and means, orientational knowledge is knowledge of justified ends and aims. Instrumental knowledge is positive knowledge, orientational knowledge is regulative knowledge. And things do not look very good for regulative knowledge today. Science has lost sight of this knowledge – and, to a large extent, society has as well. The consequences are weakness of orientation (though not yet loss of orientation), self-doubt and the tendency towards fundamentalism of different kinds." (Source of the English citation: [13]). This classic analysis is at the heart of it: we know more and more – but less and less what we should do. The types of surrender to the complexity of the challenges described by Rebecca Costa in her above-cited book [8], such as ignoring, delaying, trivializing or compensating, are consequences of this situation.

Today, nature museums should actually provide both instrumental knowledge and orientational knowledge. Thanks to their object orientation, they facilitate an ideal access, with all senses, to instrumental knowledge in order to make the visitor experience and understand complex relationships, such as the functioning of evolution, organs, ecosystems or the system earth. Fascinating objects are ideally suited to tell complex, transdisciplinary and even cross-cultural stories. Thus, nature museums must make the mistake to merely display textbook or internet knowledge. Rather, they must aim at communicating complex, inter- and transdisciplinary correlations. A clear commitment to an aphoristic choice of subjects as well as a commitment to a "joy of seeing and learning" is no less important. This is the core of enabling a "Public Understanding of Science and Research", which today extends to such important aspects as "Citizen Science".

The corresponding orientational knowledge can be conveyed rather casually, but also in a thematically

focused way. Its quintessence should limit itself to reliable results of natural science, but nevertheless promote social and political discourse – this is the real challenge for the nature museums of the future. Climate change, energy transition, scarcity of many geo-resources, species extinction, over-fishing of the oceans, water and food supply – the variety of important topics is unlimited. To inform at the same time, in a well-balanced way, about goals such as sustainability, dynamic equilibriums, resilience, risk minimization and value priorities, is an almost impossible task, but should nevertheless be tried. In view of the transdisciplinary challenges, the arrival of the humanities and social sciences into the nature museums is foreseeable.

#### NATURE MUSEUMS ARE PART OF THE “ONE CULTURE”

Of course, we agree with Richard Louv and John Brockman when they demand that nature play a greater role in our daily as well as in our spiritual life. Nature museums are an integral part of this "third culture" and may and have to contribute to the overcoming of speechlessness between the various cultural spheres. However, it is also true that we must overcome precisely this separation between the first, second and third cultures. Holistic and non-reductionist, transdisciplinary and non-disciplinary considerations are required. Current topics such as "Green Cities", "Green Buildings", "Green Financing" give reason for hope that first steps are made in at least some sectors. There is still a long way to go to achieve a comprehensive cultural and educational concept, which makes obsolete a division into first, second, third culture, in natural sciences and humanities / social sciences, and ultimately in body and spirit.

Maybe we will never completely get over these basic dichotomies, but here the journey is the goal. And the modern nature museums with their intrinsic abilities to overcome language and cultural boundaries in all respects can act as flagships.

#### NATURAL HISTORY MUSEUMS PRACTISE EARTH SYSTEM RESEARCH, BASED ON THEIR COLLECTIONS

There's even more: Nature museums are important actors when it comes to modern earth system research: their collections are archives of the past, they contain specimens from millions or even billions of years back in time. And most nature museums are research museums, using their collections to shed light on fundamental processes like evolution, population dynamics, climate change or ecosystem networks. The curators and scientists use the collections to conduct up-to-date research that is essential to understand the earth system, the history of species, the role of man in nature, and the dynamics of interactions between mankind and planet earth. Senckenberg, for example, is running four museums, but as well eleven research institutes and stations across Germany, with more than 300 researchers, and all kind of modern research infrastructures.

The particular power and potential of nature research museums, compared to universities and other “normal” research institutions, is that, by uniting them under one single roof, they create bridges and linkages between the today highly specialized disciplines. Despite the giant progresses achieved by this specialization, the reunion of the disciplines and a holistic system view are now required, because complex systems can't be understood with isolated approaches. This in-house cooperation permits new research outcomes, like reliable scientific knowledge on how to deal with today's challenges.

This instructional (or orientational) knowledge enables society to act, to deal with today's major challenges, like climate change, biodiversity loss, land use change, resource exploitation, energy supply, health, etc. Interdisciplinary and transdisciplinary research overcomes disciplinary boundaries and involves as well non-scientific stakeholders to address these challenges and to develop systemic, realistic approaches. At Senckenberg, our vision is – together with other research museums – to promote this overarching earth system research, but as well application orientation and communication. We call our approach “Geobiodiversity research – Analyzing Biodiversity in Earth System Dynamics to Serve Science and Society”.

#### CONCLUSION

The original task of the nature museums to show the "miracles of nature" has become largely obsolete due to today's travel opportunities and digital media environments. But important new tasks have emerged: to develop an emotional relationship with nature, to develop an enlightened evolutionary self-understanding, to provide instrumental and orientational knowledge regarding nature and, in this sense, to be an integral part of the "one culture", which triggers and accompanies important social and political discourses.

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See also, about the role of nature museums and the risks they are facing today:

<http://www.nature.com/news/museums-the-endangered-dead-1.16942>

[https://www.nytimes.com/2016/04/03/opinion/ournatural-history-endangered.html?ref=opinion&\\_r=0](https://www.nytimes.com/2016/04/03/opinion/ournatural-history-endangered.html?ref=opinion&_r=0)

<https://strangebehaviors.wordpress.com/2016/04/01/how-natural-history-museums-save-the-world/>

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