



Outlook Earth

Research on global change



Biodiversity: The great extinction?

Research on biodiversity conservation

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Biodiversity secures our future

Biodiversity is the foundation of our existence. It is more than just animal and plant diversity. It is about the entire spectrum of life on earth, the genetic diversity within species, and the ecosystems and their benefits to people.

We humans benefit enormously from the complex interactions of a wide range of different living beings and habitats. These interactions give us oxygen, they deliver clean water, they regulate the climate, and they provide food and medicines. A report by the Intergovernmental Platform on Biodiversity and Ecosystems Services (IPBES published in 2016) reveals that 75 percent of global food plants are at least partially dependent on pollination by animals, e. g. bees. Today, we exploit 50 000 to 70 000 plant species solely for medicinal purposes.

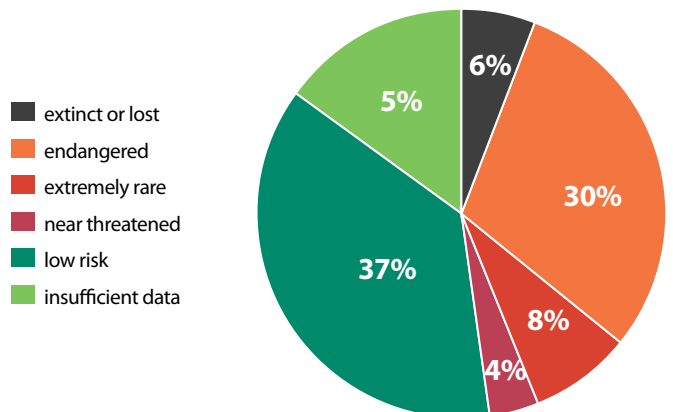
The growing human population consumes more and more resources at an ever faster pace. Seas are being overfished, forests converted into fields and once diverse landscapes impoverished by monocultures. An increasing number of ecosystems around the world are being destroyed. Their disappearance has already led to an alarming decline in the earth's natural wealth. In addition, climate change is reinforcing the risk of species becoming extinct as a result of increased floods and droughts. About 150 species worldwide become extinct every day.

Today, in a similar way to climate change, the loss of species is regarded as a political and societal challenge of the gravest urgency. For this reason, the United Nations passed the Convention on Biological Diversity (CBD) as early as 1992. The loss of biological diversity can even be noticed in Germany: a quarter of all plants and a third of all animal species are regarded as endangered. With its National Strategy on Biological Diversity, the German Federal Government has set itself the target of counteracting this trend.

As a building block in this strategy, the Federal Ministry of Education and Research promotes the development of methods for cataloguing the enormous biodiversity on land and in the oceans. The aim here is to obtain reliable data for the loss of biodiversity and examine biodiversity protection approaches. These and other investigations also contribute substantially to the IPBES World Biodiversity Council reports, which summarise the global status of species loss and provide recommendations for action in terms of the protection and sustainable use of biodiversity.

This issue puts the spotlight on the work of the IPBES as well as on a variety of research projects aimed at preserving and sustainably using biodiversity.

Risk situation for fauna, flora and fungi in Germany

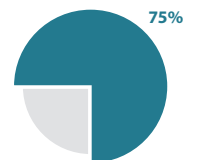


Source: based on Federal Agency for Nature Conservation, 2015

Relevance of animal pollinators for food plants



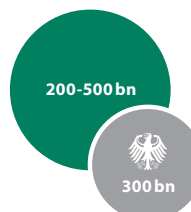
Pollinated by bees:
numerous fruit and vegetable species,
among others, seeds and nuts, soya,
cocoa, coffee and vanilla.



of global food plants are at least partially dependent on pollinators.

Source: based on IPBES, 2016

Pollinator's economic performance



Five to eight percent of global plant production can be exclusively traced back to animal pollination. These pollination services correspond to a global annual market value between 200 and more than 500 billion euros. In comparison: the Federal Republic of Germany's 2015 budget was around 300 billion euros.

Source: based on IPBES, 2016

Photo: Carola Radke, MfN Berlin



“Merely managing nature will not be sufficient to save the world.”

*Prof. Johannes Vogel,
General Director, Museum für Naturkunde (MfN), Berlin*

A third of all plants and animals in Germany are endangered. How serious is the situation really if certain insects or plants become extinct?

If one follows evolution and selection, then every species alive today represents a success model in the 3.8 billion year game of life. Here, we can learn a lot, but only if species continue to exist. Let me give you an example: many amphibians, e. g. frogs, are acutely endangered in their habitats by ongoing environmental pollution, diseases and the destruction of habitats by humans. But fewer frogs also mean more insects such as mosquitoes, which spread Zika or malaria. Often, we cannot even begin to estimate the consequences of the extinction of a species.

According to very rough estimates, between 50 and 150 species become extinct every day. Can this process be stopped?

Yes, if we start to think globally, reduce consumption and aim for intelligent solutions and not just “business as usual”. Social and scientific solutions must be developed together – here, natural history museums are needed as intermediaries and change makers. In the end, though, the solutions are actions – that is, in society and in politics.

How important is the work of IPBES for biodiversity?

IPBES can play an important role if it sees itself as an active organisation taking up a position for nature. Merely managing nature or balancing divergent political interests to arrive at the smallest common denominator will not be sufficient to save the world. In addition, the global biodiversity research community, and the remaining research community, must become as successfully vocal as climate research; particle physics or space travel – that’s still a long way off.

What can a natural history museum such as MfN in Berlin contribute to maintaining biodiversity?

The Museum für Naturkunde in Berlin and similar organisations must lead the dialogue between society, policy makers and science in order to animate the many people we welcome as visitors to the museum (in 2016 probably more than 750 000 people will have visited the MfN) away from just thinking about and towards acting on behalf of nature and the environment. Our organisation’s multilateral funding by the state of Berlin, the German Federal Ministry of Education and Research, as well as the MfN’s membership in the Leibniz Gemeinschaft, helps greatly here.

Can economics and maintaining biodiversity be reconciled?

The German Bioeconomy Council and the National Bioeconomy Strategy demonstrate how this can be done. Here, bioeconomy is understood as a move towards a sustainable and smart economy – but the difficult pathway needed to arrive there must also be scientifically and politically driven.

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IPBES: A bridge between politics and science

Animal and plant species are becoming extinct globally, natural habitats are being destroyed. In order to assess this trend and develop policy-relevant options for action to preserve biodiversity and use it sustainably, the United Nations founded in 2012 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). IPBES successfully finalised its first reports in early 2016. They convincingly demonstrate the consequences of the loss of biological diversity for humans and nature.

"Biodiversity is our future. It provides solutions to numerous problems which we are now facing or will soon be facing. We must therefore protect our biodiversity to retain possibilities for the future", says Anne Larigauderie. The French ecologist is the Executive Secretary of IPBES.

IPBES, which currently has 125 member states, is an intergovernmental body, similar to the Intergovernmental Panel on Climate Change (IPCC). No research work is carried out beneath the umbrella of the IPBES; instead, IPBES assesses and summarises current scientific knowledge and data. These assessments are carried out by a large number of international scientists. The results are a biodiversity inventory on the one hand and developing policy-relevant but not policy-prescriptive options for action on the other hand. IPBES also aims to further reinforce awareness of the value of biological diversity in politics and research, and among the wider public.

The international IPBES secretariat is located in Bonn, Germany. In order to also give IPBES in Germany the necessary impetus, the Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety established the German IPBES Coordination Office in Bonn at the DLR Project Management Agency (DLR-PT). "It is our job to support international processes and to directly aid the government in the implementation of

the IPBES work programme", says Mariam Akhtar-Schuster, head of the German IPBES Coordination Office. Among other things,



Photo: Uta von Witsch, DLR-PT

IPBES plenary session in Kuala Lumpur, Malaysia, February 2016

she coordinates the participation of German experts in the World Biodiversity Council: More than 40 scientists from Germany have participated in the work of IPBES until 2016.

At the plenary session in Kuala Lumpur in 2016, the IPBES member states, including Germany, negotiated and approved the first two completed scientific IPBES reports on "Pollinators, Pollination and Food Production" and "Scenarios and Modelling". Due to the alarming situation of pollinators worldwide, the IPBES assessment on "Pollinators" attracted particular attention. Pollination by animals plays a central role in nature's functionality and efficiency. Almost 90 percent of the world's flowering plants depend, at least partially, on the transportation of pollen by animals. The report quantifies the annual market value of global crop yields relying on pollination services at 200 to more than 500 billion euros. This includes products for the textiles, pharmaceuticals and constructions industries, as well as for the bioenergy sector. In addition, many of these plants represent sources of essential nutrients such as vitamin A, iron or folic acid, for example, and are thus indispensable for our health.

According to the report, the number of pollinators is decreasing dramatically, particularly in Western Europe and North America. Wild species are predominantly affected, among them 20 000 species of bees alone, but also flies, butterflies, moths, wasps and beetles, birds and bats. The experts blame inter alia the conversion of natural environments for use, e. g. the spread of intensive agriculture and the use of pesticides. "The IPBES assessment reports are important milestones", says Mariam Akhtar-Schuster. "As a next step we would like actions to emerge from these scientific assessments. If the findings of the IPBES assessments lead to internationally endorsed actions at the meeting of the signatory states to the biodiversity convention in Cancún in 2016, it would be an important step in the right direction."

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Cross-border cooperation for maintaining biodiversity

Rivers, mountains, forests: animals and plants do not know any national boundaries. Therefore, cross-border cooperation in research and protection of biological diversity is indispensable. This issue plays an important role within the EU: the aim is to halt the loss of biodiversity by 2020 by adopting a Europe-wide strategy. In order to jointly address this challenge, 19 nations participate in the European BiodivERsA network. They focus their biodiversity research on the needs of society.

Founded in 2005, the European Research Area-Net (ERA-Net) BiodivERsA aims at pooling scientific expertise and developing joint strategies for protecting biodiversity. The BiodivERsA research calls address current, politically relevant problems. The results are incorporated, for example, into the reports of IPBES, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

The DLR project management agency (DLR-PT) participates in the network as one of the 32 national funding organisations from 19 countries, including overseas partners. Co-funded by the European Commission, the total funding in the current call amounts to approximately 35 million euros. To date, 47 cross-border projects have been funded and the network continues to grow.

"These are complex projects. Yet, maintaining biodiversity is at the centre of them all", says Dr Rainer Sodtke, who manages the network at DLR-PT. In general, partners from five countries participate per project. Here, the research problems are as diverse as the manifold funding philosophies. However, the common theme is always maintaining biodiversity and ecosystem services, whether in water bodies, forests, agriculture or viticulture. "It is important to the participants that their work has practical relevance."

A typical example is that of the Federal Ministry of Education and Research co-funded project PromESSinG – "Management Concept for Central European Vineyard Ecosystems: Promoting Ecosystem Services in Grapes". The researchers are investigating: How important is vineyard biodiver-



Photo: Sven Bacher, Fribourg

Investigation area in Wallis, Switzerland

sity for viticulture? How does biodiversity contribute to pest and weed control or water storage? "There are large knowledge gaps in terms of the interactions between biodiversity and the benefits for humans", says Professor Ilona Leyer, project coordinator at Geisenheim University. The wine producers are highly interested in cooperating with the project, because improvements in soil quality or pest regulation could also reduce the workload in the vineyard and enhance the quality of the wine.

In addition to the exceptionally picturesque research locations, the special characteristic of this project lies in the nature of the collaboration: it is jointly implemented by partners from France, Switzerland, Austria, Romania and Germany. Investigations are carried out in all five countries and subsequently compared. The jointly developed recommendations for action are made available to a large number of stakeholders and policy makers.



Photo: Ilona Leyer, Geisenheim

Vineyard flora as an important element of biodiversity

Cross-border collaboration is also of interest beyond the research topics. "Working with European partners was be especially fruitful", Ilona Leyer emphasises. Last but not least, postgraduate students get to enjoy a transnational education. "The famous view over the horizon may be a challenge, but it is exciting and instructive for all concerned."



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GBOL: The library of life

The ambitious aim of the "German Barcode of Life" (GBOL) project is to register all animal and plant species in Germany. Since 2011 an alliance of twelve academic institutions together with so-called citizen scientists collaborates on a genetic database which will allow an automated identification of fauna and flora. It will also enable the early-warning identification of forestry pathogens with the aid of a chip. The GBOL project contributes to the global collection of DNA barcodes of all species.



Photo: Eckhard von Raab-Straube

The taxonomy coordinator Ralf Hand collects alpine plants

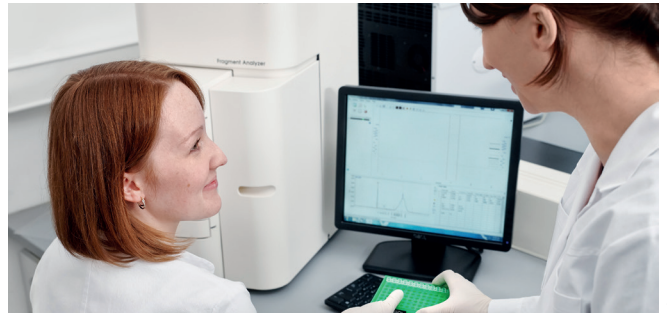


Photo: ZFMK, Bonn

Species identification in the test tube in seconds

"We would really like to investigate all animal and plant species in Germany", says Dr Matthias Geiger and knows that he cannot satisfy this scientific curiosity. The problem is not only time or money, but rather the limited number of taxonomic experts. "This knowledge is barely taught at universities any more", regrets the ichthyologist from the Zoologisches Forschungsmuseum Alexander Koenig in Bonn. He and his colleagues therefore need the help of experts working outside of academic institutions.

Outside of academic institutions, biologists, members of natural history clubs or retired experts, who studied the material earlier out of pure passion, are involved and have knowledge that often equals that of professional specialists or taxonomists. Around 400 of these so-called citizen scientists are already engaged in the characterisation of the German fauna and flora.

Geiger coordinates the GBOL project, which is funded by the Federal Ministry of Education and Research. The project

team includes natural history museums, universities and German research institutes. Moreover, the "Molecular Taxonomy of Marine Organisms" project at the Senckenberg Institute in Wilhelmshaven (see page 7) is also associated with the venture. The experts have been working on a DNA barcode reference library since 2011. The organisms are identified and archived as reference specimens. In addition, DNA sequences (DNA barcodes) from every species are registered in an open access database. This allows unknown specimens taken from the environment to be compared to the database and allocated to a species.

One third of German animals and plants have already been registered during the first four years; this represents almost 20 000 species. The aim is to include half of all representatives in the database by 2018. Particular attention is now drawn to cataloguing those organisms that are of economic importance. "For example, let us look at fungi, which may be harmful in forestry", says Geiger. If forests are infected, it would be extremely useful to determine at an early stage whether the species was harmless or harmful. This would be possible using an Eco-Chip,

which delivers answers reliably and quickly. Similar tools of benefit to agriculture, medicine or environmental protection could then be developed on the basis of the GBOL results.

With this project, Germany is driving European efforts to improve the transnational DNA barcoding network. Such international strategies are needed to respond to the extinction of species and global change processes. A joint system for the rapid identification of species is therefore becoming increasingly urgent. This is why it is also important to secure the knowledge of the few remaining taxonomists.



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North Sea fauna: Undiscovered biodiversity

Seas and oceans are the largest habitats on earth. They regulate the climate, and provide food and natural resources. Yet they remain largely unexplored. This is why the seas and oceans are at the focus of the Federal Ministry of Education and Research's 2016/17 Science Year under the headline "Discover, Use, Protect". The project, dealing with molecular biology-based identification of North Sea fauna, serves to impressively underline this headline. The resulting sequence libraries thus facilitate reliable species identification, which serves biodiversity protection on one side, and can be used to identify fish products such as fish fingers on the other.

The world's oceans conceal enormous biodiversity, a large percentage of which is, however, still completely unknown. "Many scientists travel to the tropics or investigate the deep sea", says Dr Michael Raupach. "However, over the last six years we have researched right on our doorstep." Numerous organisms in the North Sea are not even characterised. The biologist leads a group of young researchers which was founded at the Senckenberg Institute in Wilhelmshaven. Under the project name "Molecular Taxonomy of Marine Organisms", it tests new methods for quickly identifying North Sea fauna and thus recording biodiversity. This is the objective followed by the jointly funded Federal Ministry of Education and Research and the State of Lower Saxony project.

"With a little knowledge, of course, one can differentiate a herring from a plaice based on purely external features", says Raupach. "However, when it comes to identifying eggs and larvae, things get more difficult." Generally, only highly experienced specialists, known as taxonomists, are capable of differentiating organisms based on microscopic details. Morphological classification is not only complex, it is sometimes even impossible. However, identification is crucial, says Raupach, for example to discover how species composition are modified as a result of environmental and anthropological impacts, or how greatly in need of protection individual habitats and species are. To this end, the research group relies on molecular procedures based on the fact that DNA always remains unchanged, in the egg just as in the adult organism. A number of these methods were tested in



Photo: DZMB Senckenberg am Meer

Samples in alcohol

Wilhelmshaven: from so-called bar-coding, where a gene fragment from an individual is investigated, to what is known as high throughput sequencing, where thousands of gene fragments from a number of individuals in a sample are simultaneously analysed.

The properties of proteins were also investigated in a mass spectrometer to determine their usefulness in identifying species. The research group investigated different molecular dyeing methods and developed probes using dyes to identify important commercial fish species - successfully. The probes will now be used to identify fish eggs.

"We have set standards", Raupach summarises. The six-strong group of young researchers can now present the data from more than 10 000 individuals. Here, the head of the group emphasises, we started at "zero", networked with other institutes and can now recommend



Photo: DZMB Senckenberg am Meer

Molecular biological studies of these samples

methods that are viable for both environmental expert reports and food control. And there is a consumer-oriented benefit, as Raupach likes to explain: "With regard to frozen products, I can now tell exactly whether they are truly produced from cod or another fish."



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