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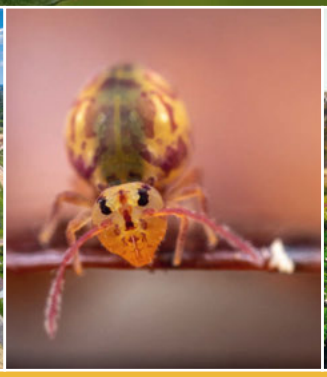

Faktencheck Artenvielfalt

Assessment of the status of biodiversity and prospects for conservation in Germany

Summary for Societal Decision Making

oekom science

Introductory remarks

We live in times of rapid change and multiple crises. One of these is the biodiversity crisis. This refers to the global loss of biodiversity caused by us humans: the disappearance of habitats, the rapid change of biotic communities, the shrinking of animal and plant populations, their genetic impoverishment and ultimately their extinction. As a consequence, the functioning and performance of ecosystems are also changing, often for the worse. These relationships were impressively summarised for our planet in the report by the World Biodiversity Council (IPBES 2019).

But how is the biodiversity crisis manifesting itself in Germany? How is the biodiversity of our native habitats changing? What are the reasons for these changes, what are the consequences for our ecosystems and thus for our livelihoods? What efforts are we making to protect and promote biodiversity? And how can we start transforming our economy *with* and *for* biodiversity?

Despite the importance of these issues, there is as yet no representative and long-term monitoring of biodiversity and its influencing factors in Germany. Nor is there any systematic recording of how our ecosystems are performing or how successful support measures have been. At the same time, hardly any other country conducts as much research and surveys on biodiversity as Germany – at universities, research institutions, societies and associations. Scientific breakthroughs in recent decades – think of automatic image recognition or genetic identification methods, such as metabarcoding – have generated a flood of new data and findings that can make an important contribution to practical applications for conserving biodiversity.

In the *Faktencheck Artenvielfalt*, a project by the Federal Ministry of Education and Research (BMBF) Research Initiative for the Conservation of Biodiversity [*BMBF-Forschungsinitiative zum Erhalt der Artenvielfalt* – FEdA, (www.feda.bio)], more than 150 authors from a wide range of scientific and practical disciplines have joined forces. Over 200 other experts from scientific organisations, associations and authorities supported the *Faktencheck Artenvielfalt* in a two-stage review process. We are united by the goal of comprehensively analysing the current state of knowledge on biological diversity in Germany and evaluating options for action to conserve and use biological diversity sustainably. In doing so, we want to help Germany achieve the internationally agreed biodiversity targets and thus play our part in the global conservation of biodiversity – for its own sake, as a natural basis for human well-being and as part of our culture.

The *Faktencheck Artenvielfalt* is about biodiversity in all its facets. In addition to species diversity, this also includes functional and genetic diversity as well as habitat diversity. We use the terms »biological diversity« and »biodiversity« synonymously, the latter in compound words due to its brevity (e.g. »biodiversity monitoring«). Overall, we have addressed the following topics for the main habitats of agricultural and open land, forest, inland water and floodplains, coasts and coastal waters, urban areas and the soil habitat (Fig. 1): (1) Status and trends in biodiversity and (2) their impact on ecosystem services, (3) direct and (4) indirect drivers of biodiversity change, (5) instruments and measures to promote biodiversity and (6) mechanisms for societal transformative change moving towards sustainability (Fig. 2). An additional chapter was dedicated to the overarching topics of »indirect drivers« and »transformation potential«. The *Faktencheck Artenvielfalt* has analysed over 6,000 publications, which are listed in a specially developed database (https://www.feda.bio/de/faktencheck-artenvielfalt-literaturdatenbank/). In addition, we have compiled and analysed a dataset of over 15,000 biodiversity time series. The broad approach of the *Faktencheck Artenvielfalt* allows us to identify existing knowledge gaps quite precisely, which we should be aware of when making political decisions (you can find the full report here: www.oekom.de/9783987260957).

The focus of the *Faktencheck Artenvielfalt* is on Germany. The recently published *10MustKnows24* summarise findings on biodiversity conservation at a global level and derive recommendations for policymakers. Both approaches complement each other and emphasise the urgency of action to overcome the biodiversity crisis and highlight options for action to protect and use biodiversity sustainably.

During the time it took to compile the *Faktencheck Artenvielfalt*, people in Germany realised that a liberal democracy cannot be taken for granted here either. The boundaries of what can be said are shifting. The familiar recipes for undermining democracies are also being tried out in Germany. The basic ingredients are hostility to science, denial of facts and active dissemination of misinformation. This book is an expression of our conviction that knowledge is the basis for solutions to the

biodiversity crisis. However, although pooling of knowledge is a necessary prerequisite for the essential process of transformative change, this alone is insufficient. The necessary change will only come about if it is supported by values and convictions – and it can only take place if these are compatible with our constitution.

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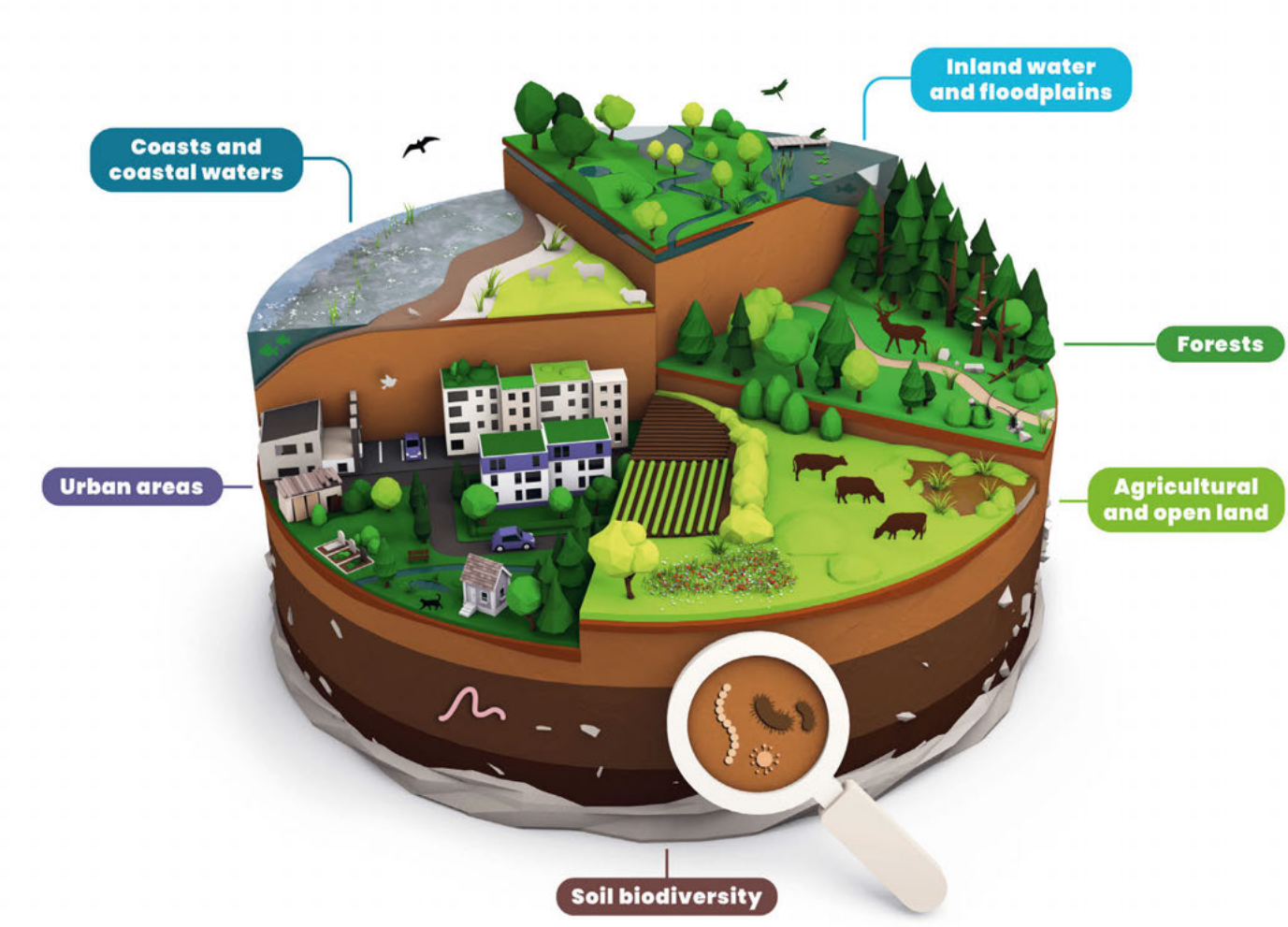


Figure 1: Habitats in the *Faktencheck Artenvielfalt*

Forewords

Veronika von Messling

Veronika von Messling

Liebe Leserinnen und Leser,
wir sehen es auch bei uns in Deutschland: Lebensräume gehen verloren, und immer mehr Arten sterben aus. Zum Teil sind die Ökosysteme der Welt, in der wir leben, aus dem Gleichgewicht geraten. Die Herausforderungen sind groß. Umso wichtiger ist es, dass wir entschlossen handeln und unsere natürlichen Lebensgrundlagen schützen.

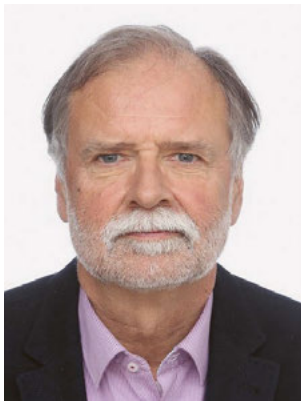
Mir geht es um die Frage, wie dies gelingen kann. Dafür ist es unerlässlich, dass wir die Lage genau analysieren, die konkreten Veränderungen sehen und ihre Ursachen verstehen. Der *Faktencheck Artenvielfalt* setzt hier an. Die beteiligten Wissenschaftlerinnen und Wissenschaftler haben große Wissenslücken zur Biodiversität in Deutschland geschlossen und zeigen Chancen auf, wie wir die Artenvielfalt erhalten und nachhaltig nutzen können. Für diese engagierte Arbeit danke ich allen Beteiligten. Das Thema hat für uns im Ministerium und in der Bundesregierung besondere Priorität und ist Teil der konkreten Missionen, die unsere Zukunftsstrategie als der zentrale Wegweiser für Forschung und Innovation benennt.

Schauen wir auch auf die Lösungen. Wissenschaft und Innovation eröffnen uns neue Chancen, um unsere Ökosysteme effektiv zu schützen. Neue Geoinformationssysteme, fortschrittliche Technologien zur Analyse von Umwelt-DNA und Auswertungen auf der Grundlage künstlicher Intelligenz tragen dazu bei, zielgenaue Maßnahmen gegen den Artenverlust zu ergreifen.

Wir haben es in der Hand, diese Herausforderung anzugehen und etwas zu verändern. Jede und jeder Einzelne kann dazu einen Beitrag leisten: Das fängt im Alltag an, führt über die ehrenamtliche Naturschutzarbeit bis hin zur Bürgerwissenschaft für den Erhalt der Biodiversität. Lassen auch Sie sich inspirieren. Ich wünsche Ihnen eine interessante Lektüre.

Prof. Dr Veronika von Messling - Head of the Life Sciences Division at the Federal Ministry of Education and Research (BMBF)

Sandra Diaz



Volker Mosbrugger

Sandra Diaz

Humans have changed the face of the Earth, forests and wetlands are shrinking and species are being lost faster than at any time in human history. The IPBES Global Assessment, released in 2019, made many people around the world aware of these facts. However, national decision makers need much more detail and regional granularity in order to act effectively.

The *Faktencheck Artenvielfalt* is an impressive achievement, building on thousands of papers and reports, using a newly assembled dataset with over 15,000 time series on animal and plant species, and combining the efforts of natural and social scientists. It goes well beyond stating the biodiversity facts to identify the difficult social, economic and institutional factors that conspire against the effectiveness or scalability of the measures that could revert these problematic trends. It is also visionary in linking biodiversity with human rights and the rights of nature. It certainly sets an example and a very high standard for other national assessments to come.

Prof. Dr Sandra Díaz - Co-Chair of the Global Report of the World Biodiversity Council (IPBES)

Volker Mosbrugger

We all know it: humanity is currently destroying its life-support system - the biosphere - at a rapid pace, and we are increasingly feeling the humanitarian and economic consequences. But do we know enough to be able to successfully take countermeasures? Unfortunately, the answer is no, and this even applies to Germany, whose natural capital is among the best researched in the world. As part of the "BMBF Research Initiative for the Conservation of Biodiversity" (*FEdA*), an interdisciplinary team of over 150 researchers has therefore set itself the goal of compiling a "systemic anamnesis" of the biodiversity crisis in large habitats in Germany based on available data, which is unprecedented in its spatial and contextual depth of detail and complexity. The result is a highly impressive reference work that we urgently need in order to take practical and effective measures to conserve biodiversity in Germany. The hope is that there will be regular updates on this in the context of the current establishment of a "National Biodiversity Monitoring Centre".

Prof. Dr Volker Mosbrugger - Spokesperson for the BMBF Research Initiative for the Conservation of Biodiversity (FEdA)

Acknowledgements

The *Faktencheck Artenvielfalt – Assessment of the status of biodiversity and prospects for conservation in Germany* is the work of a remarkably large number of committed people, many of whom have volunteered their expertise.

Firstly, we would like to thank our many authors – experts in natural sciences, social sciences and from the field – who have contributed their knowledge and time in countless meetings and workshops as coordinating lead authors and contributing authors. They not only provided extensive text contributions themselves, but also acted as internal reviewers. Without all of them, a work like this would not have been possible. We would also like to thank their institutions, which have given them the freedom to do so.

Our authors were supported in their work by project researchers, namely Julia S. Ellerbrok, Christian K. Feld, Sven Grüner, Dorothee Hodapp, Maria Sporbert, Ludwig Lettenmaier, Hong Hanh Nguyen, Christian Ristok, Anja Schmidt, Vera Schreiner, and Theresa Spatz, as well as by our assistant Lea von Sivers. As a great team, they formed the core for the *Faktencheck Artenvielfalt*. They have provided significant impetus in terms of content and ensured coherence.

Special thanks go to all those who have supported us with one or more external reviews, both as individuals and as authorities and institutions. This critical monitoring was essential for quality assurance. In many cases, it has led to additional research and re-evaluations and significantly improved the result.

We would also like to thank the BMBF Research Initiative for the Conservation of Biodiversity (FEdA), in particular Volker Mosbrugger and Julian Taffner, as well as the project management organisation VDI VDE IT and the Federal Ministry of Education and Research, in particular Matthias Boysen and Christian Böhm, for their ongoing support, commitment and advice. We would also like to thank Daniela Leitner for creating the attractive graphics and her support in the creative process.

We consider ourselves lucky to have been part of such an exciting process and would like to thank everyone involved for their committed, cooperative and inspiring collaboration.

Christian Wirth, Nina Farwig, Jori Maylin Marx, Helge Bruelheide and Josef Settele

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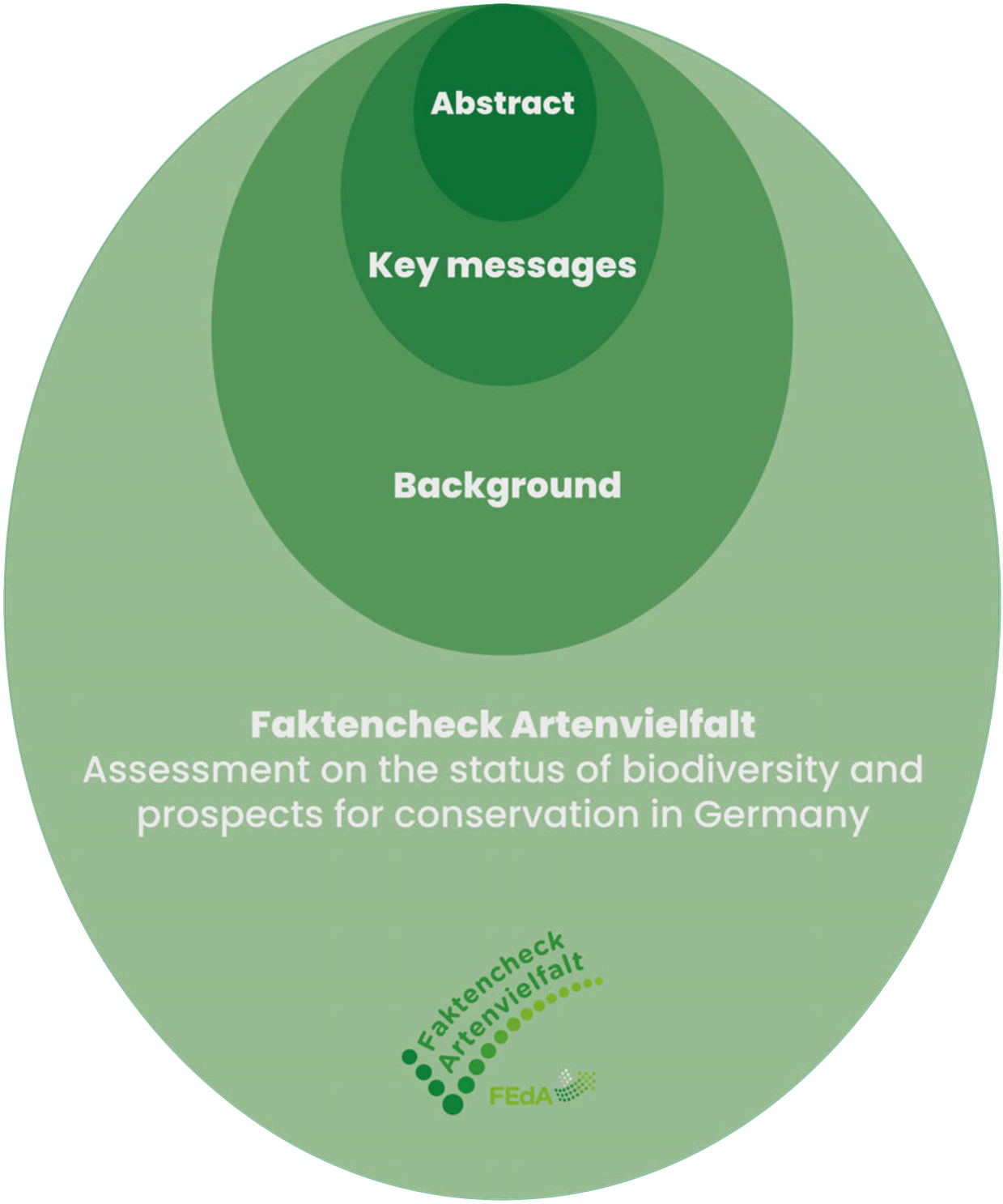
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Abstract

The *Faktencheck Artenvielfalt* summarises knowledge about biological diversity in Germany. This includes, among other things, the diversity of habitats, biological species and the genetic make-up within species. The *Faktencheck Artenvielfalt* determines the status and trends in biodiversity and the direct and indirect causes of these trends. It analyses their impact on ecosystem services that determine our well-being, as well as practical and societal options for conservation, sustainable use and restoration of biodiversity. In brief, the important results are that the diversity of habitats is decreasing. More than half of Germany's habitat types are in an ecologically unfavourable state, and valuable habitats are still disappearing (key statement 1). As a result, populations of many species and presumably also genetic variants are declining. A third of all species analysed are endangered, and around 3% are considered extinct (2). The Red Lists provide the most comprehensive expert assessment of the status of species and habitats. Initial synthesis results on biodiversity trends can be found in the literature (4). In addition, a new dataset with over 15,000 time series on animal and plant species was compiled and analysed in the *Faktencheck Artenvielfalt*. This was necessary because there is no long-term monitoring of biodiversity in Germany that is representative of the important species groups and ecosystems (3). The analysis shows that trends in biodiversity over longer time series are more often negative than positive, despite high variability (5). Negative trends are particularly pronounced in the invertebrate communities of forests, inland water and floodplains, as well as coasts and coastal waters, and in birds within the agricultural landscape. The data situation for many habitats and species groups is inadequate; this applies in particular to the biodiversity of our soils (5).

Our well-being and economic activity depend on the performance and resilience of our ecosystems (7). Research in recent decades has shown that the performance of ecosystems is enhanced and stabilised by biodiversity (8). The diversity of plant species in forests, meadows and urban green spaces significantly increases the diversity of other groups of organisms (animals, fungi, microorganisms). Ecosystems with a high level of biodiversity – not least in the soil – can provide a wider range of ecosystem services and better maintain their performance in the face of environmental changes, such as climate change (8, 9, 10). They are less dependent on an external supply of energy and chemicals and can therefore be managed more sustainably (8, 9). Managing »with« biodiversity strengthens both land use systems and nature conservation. There have not been many studies on how biodiversity contributes to our culture, but is a key motivation for protecting it (12).

Much of the loss of biodiversity occurred before the start of systematic monitoring (ca. 1850 - 1970) due to land sealing, land consolidation, plantation farming, river straightening, untreated sewage, coastal protection measures and the large-scale drainage of the landscape, especially of floodplains and fens and bogs (13). This can only be directly proven in exceptional cases by historical time series, but can be plausibly concluded from the comparison of today's natural/extensively used ecosystems with heavily modified/intensively used ones. The main causes of the lack of recovery or the continued loss of biodiversity are the intensification of agricultural use with negative effects on neighbouring ecosystems, the steady decline of many habitat types and a deterioration in habitat quality, particularly due to pollution and nutrient inputs (14). Invasive species have a negative impact on native biodiversity, especially in running and coastal waters (18). Climate change is already significantly altering biodiversity (15). Cold-tolerant species are declining, species with high temperature requirements are increasing and species from southern regions are immigrating. The impact on the biodiversity of our habitats cannot yet be estimated. Climate change can amplify the negative impact of other drivers of biodiversity loss.

The *Faktencheck Artenvielfalt* documents a number of positive developments that impressively show that biodiversity can recover if negative drivers are reduced and the quality of habitats is improved. For example, the diversity of invertebrates in watercourses has recovered on a large scale since 1970 as a result of wastewater treatment. The strong increase in forest bird populations since 2010 is also associated with an improvement in forest structure. Conservation science and practice knows measures to promote biodiversity for each habitat type, including the designation of protected areas, changes in management (e.g. conversion to organic farming, promotion of biotope trees and deadwood in forests, low-impact fishing methods in coastal waters, insect-friendly mowing regimes) or »impulse measures« (river restoration, rewetting of peatlands, colonisation of species) (27, 28). However, the effectiveness of these

measures often only unfolds in a suitable combination. For example, the designation of protected areas without site-adapted management is often unsuccessful (26, 27). When it comes to area protection, habitat quality is more important than the size of a contiguous protected area. In view of Germany's fragmented cultural landscape and the high mobility of many species, it would therefore appear more favourable to establish many small protected areas than a few large ones under the planned expansion of strictly protected areas to 10% of the area. There must be no competition for land between the protection of natural processes (natural dynamics) and the protection of valuable used habitats in the cultural landscape. New sustainable land use systems that combine use and biodiversity protection must be promoted for areas outside protected areas. Proven measures can produce unexpected results under climate change conditions. In future, the effectiveness of measures should be recorded in a standardised way by means of performance reviews, and knowledge of proven management concepts should be made more accessible. Modern automated monitoring methods could support performance review in the future (6, 29).

The social framework conditions for promoting biodiversity are diverse and reflect the various interests in our society. There are international obligations (e.g. UN Convention on Biological Diversity), ambitious strategies (e.g. EU Green Deal, National Biodiversity Strategy) and laws and directives derived from these (e.g. Water Framework Directive, Habitats Directive, Marine Strategy Framework Directive). Their goals are rarely achieved (25). In addition to implementation deficits, when international agreements are not translated into applicable national law, there are above all enforcement deficits, when legal provisions can be circumvented in practice or do not have the desired effect (25). The reasons for this are a lack of willingness or understanding on the part of society, an overload of work by the authorities and, above all, a lack of coordination with the objectives and instruments of other sectors (e.g. agriculture, energy, flood protection, industry) (20, 26). This often leads to nature conservation concerns being weighed up in legal considerations (20).

So far, economic and technological drivers have mostly had an inhibiting effect on biodiversity. An incipient trend reversal in consumer behaviour towards certified food or wood products is opening up markets for sustainable business practices with a positive impact on biodiversity (22). Technical innovations can also promote biodiversity (e.g. mechanical plant protection, species-specific plant protection products) (22). The allocation of funding is recognised as an economic instrument, but should be used on the basis of success rather than measures (25, 29). When planning and promoting local measures, it must be taken into account that these can also have telecoupling effects on biodiversity in other regions of the world (21).

In order to counteract the loss of biodiversity, transformative change is necessary within the framework of the constitutional order (30, 37). Transformative change seems possible if people are made aware of the importance of biodiversity and alternative courses of action and are able to experience them (31, 32) and participate in decisions on how to protect them or determine these measures themselves (33, 36). It is also important that biodiversity indicators and their ecosystem services are included in the overall balance sheets of national economies and companies (34), that the implementation of biodiversity conservation is enshrined in high-level rights, in some cases at constitutional level, and thus made binding (35), and that all social actors support transformative change (36). A trend reversal is most likely to be made possible if it is supported by several motivations for working to protect biodiversity (37). An important chain of effects across all habitats is the extensification of land, water and sea use. This goes hand in hand with an increase in structural diversity and a reduction in nutrient inputs (38). In order to counteract biodiversity loss more successfully, the existing measures to promote biodiversity can be further developed and used in a more targeted manner (38).

Figure 2: Topics in the *Faktencheck Artenvielfalt*

Key messages

What is the state of biodiversity in Germany?

1. More than half of Germany's habitat types are in an unfavourable condition. A total of 60% of the 93 habitat types described for agricultural and open land, forests, inland water and floodplains, coasts and coastal waters and urban areas show an inadequate or poor conservation status and declining trends. The situation of habitat types in grassland, formerly species-rich fields, fens, bogs, bog woodland, swamps and springs is particularly worrying. Over half of the marine and coastal habitat types in the North Sea and Baltic Sea are endangered in the long term. In cities, near-natural habitat types and those characterised by cultural landscapes are being lost due to inner-city densification and the expansion of further (transport) infrastructure. There are only a few positive trends, e.g. in deciduous forests, but these are jeopardised by climate change. → A1

Figure 3: Red beech forest with an undergrowth of *Mercurialis*. Deciduous forests are among the few habitat types that are currently developing favourably. However, beech forests have been suffering from drought in recent years (photo: Hartmut Dierschke). *→ 1*

2. The populations of many species are declining. One third of the species analysed are endangered. Of the approximately 72,000 animal, plant and fungal species native to Germany, around 40% have so far been analysed with regard to their populations being endangered and recorded in Red Lists. Almost a third of all species on the Red Lists are endangered, i.e. they are threatened with extinction or critically endangered; around 3% are already considered extinct. Many reptile and amphibian species, as well as numerous insect species and other arthropods, are highly endangered. For the latter and many other species groups, however, the data basis necessary for reliable categorisation is lacking. Soil biodiversity has so far been represented in Red Lists to less than 5%, which is why it is hardly possible to make statements on the threat to soil biodiversity. Individual increases in population sizes are evident within the species groups of mammals, birds, butterflies and dragonflies, but not for species that depend on rare or endangered habitats. → A2

3. There is no standardised procedure for recording biodiversity in Germany. This has made it difficult to make representative statements to date. There is no standardised regular recording of biodiversity across species groups and habitats in Germany. Biodiversity surveys are carried out by numerous independent programmes run by various authorities and research institutes, as well as on a voluntary basis by associations, specialist societies or federations for selected species groups, habitats and facets of biodiversity. The initiatives are largely not coordinated with each other. This makes it difficult to link the data and to carry out a comprehensive scientific analysis and prediction of how biodiversity is developing on the whole. There is hardly any data available on changes in genetic diversity. An integrated, methodologically standardised and permanently established biodiversity monitoring system is needed to identify representative trends in biodiversity in all its facets across Germany. The purpose of this would be to better understand the causes and review the large-scale success of strategies for protecting and promoting biodiversity. → A3

4. More recent studies confirm the negative findings of the Red Lists for individual species groups. Positive developments were also detected for some groups. In recent years, a number of studies have been published for individual species groups that show a general decline in the biomass of insect communities in Germany and predominantly declining populations of butter-

fly and plant species. In contrast, the populations of many dragonfly species are increasing. In other groups of insects and plants, not only rare but also more common species are in decline. The populations of birds in agricultural and open land have declined by over half in just under 40 years. For species groups in rivers and streams, increases in species and individual numbers have been documented in recent decades, albeit starting from a very low level and still well short of a good conservation status. Overall, there is an accelerated shift towards novel biotic communities with an increasing proportion of alien species, primarily in coastal waters and large rivers. The synthesis of all these studies in this *Faktencheck Artenvielfalt* provides the most comprehensive overview to date of changes in biodiversity in Germany. → Box A

Figure 4: The populations of some species groups, such as damselflies (here: the keeled skimmer, photo: Jörg Freyhof), are currently developing positively. However, far more species are showing negative trends, e.g. many butterfly species such as the dusky large blue (photo: Josef Settele). → *4*

5. The *Faktencheck Artenvielfalt* has compiled and analysed over 15,000 time series on aspects of biotic communities' biological diversity from the literature and data surveys. Declining trends in biodiversity predominate in many habitats. Significant trends are mainly visible in longer time series. The trends in species diversity are more often negative than positive, although the methodology makes it more likely that positive trends will be recognised (see Methods). Negative trends are particularly pronounced in the invertebrate communities of forests, inland water and floodplains, as well as the coast and coastal waters. There are also different trends for subgroups within the organism groups. While the proportion of positive and negative developments in agricultural and open land is largely balanced across all plant communities, field weed communities show strongly decreasing trends. In forests, mammals show more positive than negative developments. The biodiversity of the coast and coastal waters is characterised by very high dynamics. Between individual years, around half of the species inventory in the biotic communities is being replaced, regardless of the organism group. There are hardly any representative time series for biodiversity in urban areas and soil biodiversity that allow a trend analysis. → A4

Figure 5: Observations of moth communities by means of light attraction reflect the predominantly negative developments of invertebrate species groups (photo: Dorte v. Stünzner-Karbe). → *5*

6. New technologies will revolutionise the observation of biodiversity. However, there is still a need for development. In the future, biodiversity monitoring will be greatly expanded by new methods. Some are already in use today, such as genetic species identification (metabarcoding), automatic species recognition in images from photo traps and smartphones, acoustic monitoring and remote sensing environmental monitoring. These methods can supplement conventional methods, significantly increase their temporal and spatial resolution, increase the number of species identifiers,

expand the range of species that can be observed and take new facets, such as genetic diversity, into account. Based on previous experience with these methods, however, there is still a considerable need for further development, particularly in recording individual numbers and biomasses. For some species groups, metabarcoding methods are already sufficiently developed to be used widely and with the necessary resolution, e.g. for flying insects or for freshwater fish through small amounts of DNA that organisms release into the environment (environmental DNA). → A5

Figure 6: When determining the population sizes of marine mammals such as the harbour seal, passive acoustic recording methods are now also used in addition to aerial counts (photo: Dorothee Hodapp). ⇀ *6*

What role does biodiversity play for ecosystems and us humans?

7. Biologically diverse communities provide essential benefits for us humans. In addition to supplying food and raw materials, these include essential regulatory functions, such as pollination, the maintenance of nutrient cycles, climate protection, water retention and coastal protection and protection from erosion. They also provide many important cultural benefits. The state of knowledge for Germany allows for an exemplary assessment of how changes in biodiversity affect these services. However, a comprehensive assessment of the impact of biodiversity on ecosystem services is not yet possible. → B1, B2

8. Ecosystems are more efficient and more stable in their functioning if they have a high level of biodiversity. Experiments and targeted observations in the field in Germany and Central Europe show that species-rich ecosystems are more efficient and more stable than species-poor systems. One reason for this is that different species (or functional groups of species) complement each other in many services, such as nutrient uptake, growth or decomposition (»complementarity«), support each other directly and can stand in for each other in the event of stress or after disturbances (»insurance effect«). In species-rich communities, individual species are often healthier and more productive because their pathogens, parasites and predators build up smaller populations (»dilution effect«). For these reasons, monocultures, which are the rule in agriculture and aquaculture and are also common in forestry, are more unstable. They can only be maintained with a high input of energy and chemicals (processing, fertilisation, pesticides, antibiotics). The positive effects of species diversity can presumably also be transferred to the diversity of genetic variants (genotypes) within a species, but the data situation is insufficient. → B3, B7

Figure 7: A common furrow bee pollinates the flower of a strawberry and thus fulfils an essential regulatory function (photo: Felix Fornoff). ⇀ *7*

9. High biodiversity also increases the diversity of ecosystem services. More biodiversity (species, functional groups or genotypes) is required for the simultaneous provision of several ecosystem services (»multifunctionality«) than for the optimisation of individual ecosystem services. More biodiversity is also needed if ecosystems are to perform well in the face of a variable environment over longer periods of time or over larger areas. Multifunctional, sustainable and resource-conserving land and sea use is therefore particularly dependent on a high level of biodiversity (see 8). Whether the current rates of biodiversity loss in Germany's near-natural ecosystems (see 5) are already dimin-

ishing their performance cannot be said with certainty at present. → B3, B4

10. Climate protection is a regulating ecosystem service that is particularly dependent on biodiversity. Compared to species-poor meadows, species-rich meadows sequester a particularly large amount of the greenhouse gas CO_2 as organic matter in the soil. Species-rich forests do this mainly in the living trees and in the deadwood – more so than species-poor forests. The biodiversity of soil organisms does not only increase the mineralisation of nutrients in the soil, but almost always also its long-term carbon storage. In addition, species-rich meadows and forests can buffer the temperature fluctuations on and in the soil better than species-poor ones. Species-rich meadows and forests are more resistant and resilient to climate extremes. Peatlands, on the other hand, provide climate protection with few species, but species that are valuable for nature conservation. Other regulatory services that can be demonstrably promoted by biodiversity are erosion control, water purification in water bodies and floodplains (filtration, decomposition of organic matter), pollination of flowers and the maintenance of nutrient cycles. → B4, B6

Figure 8: Near-natural raised bogs such as the Schwarze Moor in the Röhn (photo: Nina Farwig) provide important regulatory services. Bogs are characterised by a high proportion of endangered species, such as the marsh lycopod and the common sundew in the Ahlenmoor on Lake Halem (photo: Helge Bruelheide). → *10*

11. In addition to biodiversity, individual key species can also contribute strongly to ecosystem services. These are species that act as »ecosystem engineers« thanks to their unique adaptations and abilities. They form habitats for other species and drive certain processes with particularly high efficiency. The loss of key species has a disproportionately strong negative impact on ecosystem services. One example are the seagrasses of coastal waters, whose underwater meadows serve, among other things, as nurseries for fish and powerful carbon sinks. Other key species include mussels, reeds, black alder and beavers, as well as woodpecker and earthworm species. The provision of habitats for numerous other species increases the overall regulating ecosystem services. However, individual species can also have a negative impact on ecosystem services or directly on humans (»disservices«). An increase in disservices with increasing biodiversity is not known. → B5, B8, B10

Figure 9: As an ecosystem engineer, the European beaver curbs the drainage of the landscape by building dams. This promotes biodiversity and the resilience and cooling effect of ecosystems in a changing climate (photo: Pixabay-Ralf Schick). → *11*

12. Biological diversity provides numerous cultural ecosystem services. It strengthens mental health and well-being and conveys a sense of home by connecting people with their cultural and historical tradition. It also serves as an artistic and spiritual source and is important for tourism. Particularly in cities, the diversity of habitats and species demonstrably improves people's well-being. In agricultural areas, the aesthetics of the landscape are heavily dependent on the abundance of flowers

and diverse structures. Access to nature reserves or green spaces in cities leads to a deeper understanding and thus a greater appreciation of biodiversity. → B9

What are the reasons for the change in biodiversity?

13. Historically and up to the present day, the loss of habitats has significantly reduced and changed biodiversity in Germany. The existing surveys, which only began in the last few decades, therefore reflect an already impoverished biodiversity and start from a low baseline. In terrestrial habitats, the destruction and fragmentation of habitats has contributed particularly to the decline in biodiversity. In agricultural and open land, land consolidation has greatly reduced habitat diversity by reducing the amount of hedges, roadsides and small bodies of water. Species-rich meadows and pastures have been and continue to be ploughed up to create species-poor high-performance grasslands or for arable land. Historical forest usage forms, such as coppice forests and silvopasture, which are of great importance for the biodiversity of insects and birds in the forest, have almost disappeared. The drainage of the landscape has led to the loss of fens, bogs, marsh and wetland meadows, as well as floodplain, bog and swamp forests. Almost all watercourses have been profoundly altered by straightening, bank stabilisation, removal of riparian trees and shrubs or regular weed removal. Today, numerous weirs and other transverse structures interrupt the continuity of many streams and rivers, e.g. for migrating fish. As a result of water being held back by weirs upstream, watercourses lose their natural structural and flow diversity. Embankments have severely restricted the connectivity and network of the floodplains, which has led to a far-reaching loss of typical floodplain communities. The dyking and straightening of the coast as well as land reclamation have completely changed the transition between land and sea and destroyed the natural dynamics of this habitat over a large area. Densification within cities and the expansion of urban areas have led to the loss of many unsealed areas, which include important special habitats for urban biodiversity, such as brownfields, industrial nature areas and areas of urban wilderness. In almost all of these cases, this loss of habitat led to a decline in species diversity. The disappearance of habitats continues to this day. → C1

Figure 10: Freely meandering rivers with slip-off slopes and cut banks, such as the Mulde south of Dessau, promote biodiversity on land and in the water with their structural and flow diversity (photo: Christian Wirth). → *13*

14. Even within habitats, intensification of use, especially in agricultural land, but also generally in the cultivated landscape and in bodies of water, has had a strong negative impact on biodiversity. Intensification includes abandoning crop rotations, the increasing cultivation of maize and the use of fertilisers, pesticides and heavy machinery on arable land, growing cultivated grasses on grasslands and the decline in extensive grazing. Over the last few centuries, natural forest structures have often been converted into monocultures and age-class forests, a process that has only recently been counteracted by subsidy programmes. In the last two decades, the proportion of deadwood has increased. In the past, the lack of deadwood had a strong negative impact on a large number of species that depend on it. In inland water and the Baltic Sea, the input of nutrients and pesticides from intensively farmed areas and fishing has a particularly negative impact on biodiversity. In cities, the intensive maintenance of public green spaces and private gardens, e.g. through frequent mowing and mulching, the use of pesticides or increased sealing, including gravelled gardens, has a negative impact on biodiversity. In the North Sea and Baltic Sea, bottom-trawl fishing, shipping and the massive expansion of offshore wind farms in particular have negative effects on various species groups. → C1, C2

Figure 11: Construction measures such as the construction of a container terminal at the Jade-Weser Port near Wilhelmshaven destroy important coastal habitats and disconnect terrestrial and marine ecosystems. Increased shipping traffic has a negative impact, for example on harbour porpoises (photo: Kolja Beisiegel). → *14, 15*

15. Climate change and associated extreme weather events play an increasingly important role in changes to biodiversity. In Germany, average annual temperatures have risen by 1.8°C since the early 1950s, and by around 1.5°C in German marine waters since 1969. The extent of the impact of this temperature increase on biodiversity in Germany cannot yet be fully assessed. Cold-tolerant species die out or retreat to higher altitudes. Species with high temperature requirements spread and migrate from the south. The long-term net effect of these two processes on the number of species is still unclear. For agricultural and open land, it can be assumed that climate change will exacerbate the negative impact of intensification of use, for example on insect diversity. Similarly, the network of relationships between species changes when warming shifts the seasonal activity patterns of interaction partners to varying degrees, such as flowering plant and pollinator or predator and prey. This can accelerate extinction processes. Extreme periods of drought are already endangering the typical biodiversity of peatlands, wet meadows, inland water, springs and the groundwater. The extraction of water for industrial processes, drinking water production and irrigation of agricultural land causes inland water to dry up locally and lowers the groundwater level in floodplains. This jeopardises the biodiversity of these areas, including the specific groundwater fauna, and the ecosystem services they provide, e.g. the purification of groundwater. The drought damage to our forests has until now had a positive effect on biodiversity due to thinning of the forest cover and the increase in deadwood. In the long term, however, the decline of tree species with an important habitat function for other species and of certain forest habitat types could also have a negative impact on biodiversity. Most cities are already being severely affected by climate change, which is reflected in the high mortality of urban trees due to increasing heat and drought stress, among other things. → C3, C4

16. The pollution of ecosystems by wastewater, industry, agriculture and transport has direct and indirect negative effects on biodiversity in Germany. Numerous pollutants, such as pesticides and pharmaceuticals and their decomposition products, as well as microplastics and heavy metals, are sometimes harmful even in low concentrations. Many pollutants remain in the ecosystems for a long time and accumulate in the food chains. While the amount of pesticides used has increased only slightly in recent decades, the toxicity of the substances used for some species groups, such as fish or soil organisms, has risen sharply. Crop protection products also enter neighbouring areas and bodies of water, where they develop their toxic effects. The input of nutrients from agriculture and, to a lesser extent, from urban wastewater into water bodies can lead to eutrophication. This is often accompanied by oxygen depletion, and toxic blue-green algae blooms and reduces biodiversity. Only just under 10% of rivers, lakes and coastal waters in Germany are in a good ecological condition. The diversity of fungi and plants in the forest soil is reduced by nitrogen inputs from the air. In addition, there are combined inputs of various pollutants, the interactions between which can be particularly harmful to soil biodiversity. → C5

Figure 12: The stone crayfish is sensitive to pesticides. Agricultural inputs into rivers and streams destroy its habitat (photo: Julian Taffner [Terra Aliens]). → *16*

17. At least 1,015 alien species are established in Germany, 107 of those are considered invasive, i.e. they are increasing in number and spreading rapidly. They often have a negative effect on the native flora and fauna and on humans. In Germany, large rivers and coastal waters are particularly affected by invasive species. These often migrate via estuaries and canals or are introduced via shipping and aquaculture, which has already led to the displacement of native species in rivers. In terrestrial habitats, wild garden plants, such as garden bramble, knotweeds and giant hogweed, are important examples from the vascular plant group. Examples for invasive mammals are animals that originated from fur farming, such as raccoons and nutrias. Introduced fungal diseases are also of great relevance. They threaten native tree species and thus the communities that depend on them and also have a direct impact on animals, especially amphibians and insects. However, there is a lack of knowledge about the effects on the latter. In addition to the negative impact on native species communities, invasive species can also be beneficial for biodiversity, which is particularly the case in cities and on industrial brownfields. → C6

18. The effects of different drivers of biodiversity change can reinforce each other. It is known, for example, that oxygen deficiency as a result of wastewater discharges is more pronounced when rivers and streams are being dammed up simulatenously. The extreme drought in 2018 - 2020 and 2022 weakened trees to such an extent that the damaging effect of invasive fungal species was intensified. Bees are more vulnerable to pesticides if they do not have access to diverse floral resources. Due to the complexity and large number of possible interactions, predictions are currently subject to considerable uncertainty. → C7

What framework conditions exist for preserving and promoting biodiversity?

19. Political and legal framework conditions can have a positive impact on biodiversity, but should not be viewed in isolation. Laws and programmes developed to promote biodiversity are severely restricted in their effectivity by competition with instruments for other sectors (e.g. energy, agriculture, fisheries, transport, flood protection). There are a number of laws and programmes that can have a positive impact on biodiversity, such as the Habitats Directive, which serves to protect endangered habitat types and species throughout Europe. In addition, the Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) prescribe that water bodies have to achieve a good ecological status. However, other political and legal drivers limit the positive impact of nature conservation policy on biodiversity in all habitats. For example, the EU's Common Agricultural Policy (CAP), the most important funding instrument for agricultural policy, also supports non-organic farms. This results in negative effects on biodiversity, for example through the use of pesticides and mineral fertilisers. Similarly, increased fishing quotas in fisheries policy can change biodiversity in coastal waters. Competition for land also restricts the promotion of biodiversity. For example, property and transport policy promotes the sealing of soil for house and road construction. Energy policy also takes up land and changes habitats, which has a detrimental effect on biodiversity: examples include the damming of bodies of water for hydropower plants and the large-scale cultivation of maize and rapeseed to produce biogas and biofuels, which reduces crop rotation and structural richness in agricultural landscapes. Competition can be reduced by taking biodiversity more clearly into account when weighing up interests at a higher political and legal level. In addition, laws and programmes should be developed across sector boundaries. → D1

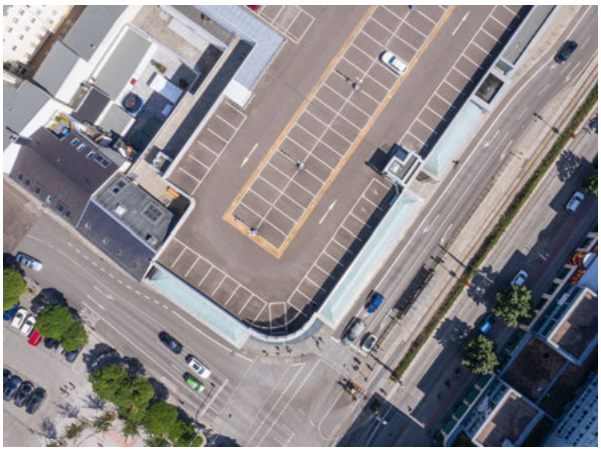


Figure 13: Due to persistently high levels of sealing, natural habitats in cities are in decline (photo: Adobe Stock). → *19*

20. Unintended effects of political or economic action can cause negative impacts on biodiversity in other regions of the world via telecoupling. These effects must be taken into account and minimised. There are examples of displacement effects where local economic developments also have negative telecoupling effects on other regions of the world. For example, reduced logging in Germany leads to a loss of forest habitats in countries with a lower protection status. Furthermore, the increase in the use of biofuels in Germany is leading to an expansion of species-poor oil palm monocultures in Indonesia. Such telecoupling effects must be embedded in an overall global concept of sustainable transformation so that global political goals for promoting biodiversity can be achieved (Policy Coherence for Development – PCD). → D2

21. To date, economic and technological influences have often had a negative impact on biodiversity. Certification systems and technical innovations can partially counteract this and promote biodiversity. Current methods of commercial agriculture, forestry and fisheries often have negative effects on biodiversity. However, economic drivers can also have a positive impact on biodiversity if there is increased demand for sustainable products from biodiversity-promoting production. Signs of changes in consumption can be seen, for example, in the fact that a growing proportion of the population in Germany regularly consumes organic food (as of 2022: one third) and purchases certified wood products. Sustainability is therefore becoming an increasingly important production factor for companies. In the future, technological innovations could have a positive impact on biodiversity. For example, digital applications for calculating fertiliser applications help to reduce substance inputs into habitats. Technological innovations for using agricultural by-products – such as the biotechnological production of insulation materials – can generate additional income for organic farms. However, many new technologies are still being tried out, and it is uncertain to what extent they can counteract the further loss of biodiversity. → D2

Figure 14: Today, organically grown produce can be found in all supermarkets (photo: Pixabay-ElasticComputeFarm). ⇀ *21*

22. A large proportion of the population, especially in urban areas, lives with little direct connection to natural ecosystems and their services, such as food production. Environmental education and nature experience programmes can counteract the alienation from nature and lack of knowledge of the importance of biodiversity for our well-being. The recent societal shift towards sustainability is likely to have a beneficial effect on biodiversity, even if the impact chains are often difficult to trace. Educational programmes on sustainability, nature experiences and sustainable regional tourism support this by bringing biodiversity to life and imparting knowledge (see 12). With well-researched articles on nature and species conservation, the media can promote interest in biodiversity and indirectly emotionalise conservation issues. This has been evident in recent years, for example, in the topics insect decline and the state of the forest in times of climate change. In cities, the establishment of environmental education centres and nature experience spaces can help to combat alienation from nature. Changes in values towards an increased appreciation of biodiversity are one explanation for the declining consumption of meat and the increasing demand for regional products. However, this demand is also influenced by other macroeconomic developments, such as rising energy prices. → D3

23. The increased occurrence of other crises, such as wars or pandemics, diverts attention away from the biodiversity crisis and can bring other political and social priorities to the fore. Communication strategies and activities for biodiversity conservation need to be critically reflected upon in times of multiple crises that place a financial and emotional burden on people. One way of doing this is to emphasise the positive aspects of biodiversity and intact habitats, for example

for health and mental balance, or the benefits of nature-based solutions for human economic activity. → D4

How do specific measures to promote biodiversity work?

24. Nature conservation policy aims to preserve and promote biodiversity through various legal and funding policy instruments. The impact of policy instruments is reduced by deficits in implementation and enforcement as well as a lack of orientation of financial incentives towards achieved results. Legal instruments, such as the Federal Nature Conservation Act or the Habitats Directive (see 19), regulate the designation of protected areas and landscape management according to the principles of good professional practice. Support programmes, such as the agri-environmental and climate measures (AECM) of the CAP, create financial incentives for measures to improve biodiversity in agriculture. To date, these instruments have not done justice to the complexity of the biodiversity crisis, as solutions are often only considered on a sectoral basis. In addition, financial incentives often only take into account the implementation of a measure, but not its success or efficiency. As a result, nature conservation policy often fails to achieve its objectives, such as in the implementation of the WFD, which in many places has not led to an improvement in the state of water bodies. At the same time, there is both a deficit in the transposition of EU directives into national law and a deficit in the practical implementation of national law. In the case of the Habitats Directive, for example, this manifests itself in the lack of development and implementation of action plans, and in the case of the WFD and MSFD in lengthy planning procedures. In order to improve the efficiency of measures, the concepts for them should be adapted more closely to the respective biological communities and their functionality, and their success should be systematically monitored and rewarded (see 28). This must be done together with the people living and working in the area in order to create local acceptance (see 32). → E1

25. The Habitats and Birds Directives are important instruments to be used as a basis for area and species protection measures. They make a key contribution to promoting biodiversity and provide the legal basis for the Europe-wide Natura 2000 network of protected areas. However, they do not reach their full potential within the current implementation method. For example, the quality and type of ongoing land use within areas protected by the Habitats Directive are often the reason for an unfavourable conservation status of habitat types and species (see 1, 2). This shows that the use or non-use required in the measures was either not formulated precisely enough or not sufficiently implemented (see 24). In coastal waters, for example, long (sometimes international) coordination and decision-making processes make concrete implementation difficult. In addition, a small area size inhibits the effectiveness of areas protected by the Habitats Directive: according to a study within the context of the *Faktencheck Artenvielfalt*, the conservation status of habitat types is rated better with increasing area size. However, if

Figure 15: In nature reserves, the preservation of biodiversity is a priority, as here in the Zadlitzbruch in the Düben Heath, Saxony (photo: Josef Settele). → *24*

Figure 16: The breeding population of the rare marsupial tit has declined sharply. It is dependent on the protection of wetlands (photo: Heike Müller). → *25*

a high conservation status and thus habitat quality can be guaranteed, it is more favourable to establish many small areas rather than a few large ones when expanding the protected area system. Smaller protected areas are easier to designate in the fragmented cultural landscape and thus cover a broader portfolio of habitat types. Many species in need of protection are mobile enough to recolonise them. In terrestrial habitats, protected areas are currently designated without taking soil biodiversity into account. Protected areas designated to promote above-ground biodiversity appear to do little to improve soil health. → E2

26. Targeted land management promotes biodiversity both inside and outside protected areas. Depending on the protected resource, the adaptation or abandonment of a form of land use or the maintenance of historical management may be necessary to conserve biodiversity. The majority of Germany's land is used agriculturally. This applies above all to areas without protection status, but also to many protected areas. Consequently, site-adapted land management is a decisive measure for creating high-quality habitats for biodiversity, especially if this is maintained in the long term through area designation. For example, reducing the use of pesticides in agriculture lowers pollution in agricultural and open land, as well as in freshwater and coastal water habitats. Other examples of biodiversity-promoting land management include conservation fishing, leaving old trees, biotope trees and deadwood in the forest, and creating and maintaining wildflower meadows in the open landscape. In urban areas, the use of extensive forms of green space management, such as gentle and reduced mowing, has a positive impact on biodiversity. New sustainable land use systems that combine the protection and use of biodiversity must also be promoted. → E3

27. One-off measures can have a positive effect on biodiversity by providing an impulse for near-natural development and improving habitat quality. The introduction of structural landscape elements, such as hedges and margins, restoration measures, such as dyke removal and rewetting, and the reintroduction of species are particularly effective. These impulse measures are particularly successful if they are coupled with long-term management and area protection. It is essential that site-adapted management is continuously reviewed, and modified if necessary. Especially in the case of restoration and reintroduction measures, it is crucial to plan an evaluation phase after implementation, as successes and failures sometimes only become apparent after several years. → E4

Figure 17: Restoration work on a previously dammed stream in the Grünbach valley near Baden-Baden (photo: Julia S. Ellerbrok). → *27*

28. In order to be able to evaluate and reward the success of specific measures, it is necessary to finance and implement target-based performance reviews. Evaluation of the success of measures should be carried out in a methodologically standardised manner with scientific design and the results should be made publicly available. This is the only way to evaluate the effectiveness of funding programmes and improve them in a targeted manner. The impact on habitat types and target species and also on other species groups that were not the target of the measures must be taken into account when reviewing performance. The immediate socio-economic and ecological context, as well as longer-term developments in the impact of the measures, should also be considered. Successful measures should be financially rewarded in a results-oriented manner, and the monitoring of measures and their success should be integrated into the political framework. → E5

How do we create a willingness to take action to preserve and promote biodiversity?

29. In order to counteract the loss of biodiversity, transformative change that questions existing systems, institutions and practices is possible and necessary within the framework of

the constitutional order. In order to achieve such a change, there needs to be a discourse on future visions (see 30). This is made possible by knowledge of the socio-ecological interconnections and a balanced approach to the dynamics that come with change. In current public planning, a change of perspectives and paradigms towards an integrated (not sectoral; see 19), public welfare-orientated and socially just strategy for biodiversity conservation would be beneficial. This reorientation must take place within the framework of the free and democratic basic principles. Self-responsible action must be made possible and requires a creative culture of participation from different social groups. The complex interaction of governmental and non-governmental control structures required for change, so-called governance, must be simultaneously informed, adaptable, integrative and accountable, and it must involve all social groups, i.e. be inclusive. → F1, F7

Figure 18: Environmental education and citizen participation convey and negotiate knowledge and values (photo: Adobe Stock). → *29*

30. Simply imparting knowledge is not enough to bring about transformative change. A link between knowledge and values is necessary. Visions that reflect different values and motivations for biodiversity conservation are helpful here. The three central justifications are »nature for nature«, which focuses on the intrinsic value of nature with its own rights, »nature for society«, which emphasises the benefits of nature for people and society, and »nature as culture«, which is based on the close connection between human cultures and traditions and nature when designing cultural landscapes. All three motivations, with their different prioritisations, can lead to visions of social change. Ideas for the future should be developed on a large spatial scale (landscape level) and in an integrative way (socio-ecological level). → F2

31. Positive changes in terms of biodiversity are often characterised by windows of opportunity being used effectively. These cannot be planned exactly, but can be anticipated within certain limits (e.g. change of government, change of mood following environmental disasters, technological and scientific breakthroughs). It makes sense to be strategically and communicatively prepared with evidence-based concepts. To achieve this, it is helpful to proactively and continuously negotiate new sustainability solutions with society and, above all, to deal with unawareness and controversial knowledge. Such a discourse is the prerequisite for recognising negative indirect drivers at an early stage and achieving ambitious biodiversity targets when windows of opportunity open up. → F3, F4

32. Resistance to transformative change can be overcome not only through financial incentives, but also by offering co-determination. Financial incentives can open up alternative sources of income during the transition phase, such as those resulting from the combination of nature conservation and tourism. This creates new professional expertise and personal interest (ownership) among those involved, which also helps to spread the idea (multiplier effect). This can be supported by working on public relations and education on biodiversity. Offering co-determination when designing use concepts and planning processes meets the fundamental desire for commitment and self-efficacy and can overcome resistance. → F4

Figure 19: Hiking in Saxon Switzerland. A combination of nature conservation and tourism can be financially attractive and support transformative change (photo: Jori Maylin Marx). → *32*

33. Indicators for biodiversity and its ecosystem services must be included in the overall balance sheets of national economies and companies. To date, traditional economic reporting has taken insufficient account of the ecological and social costs of our economic activity. Intact ecosystems with their biological diversity are not included as the basis of material and non-material prosperity. Environmental economic accounts [Umweltökonomische Gesamtrechnung (UGR)] for national economies and companies, which include biodiversity and its services and thus enable economic-ecological reporting, provide an important basis for political decisions and corporate management. This results in important positive feedback on the social discourse. Such a reporting system is now mandatory, but how this is practically organised and applied is still partially unclear. → F5

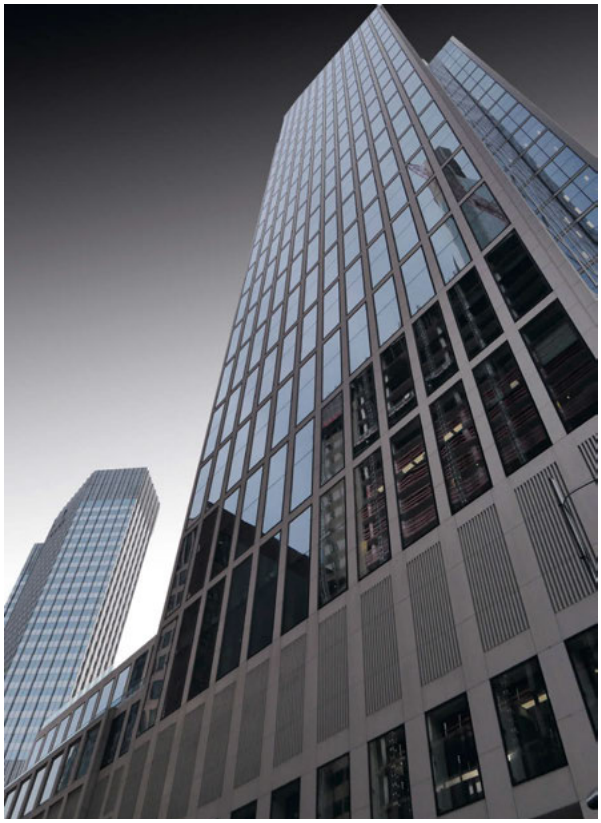


Figure 20: Since 2023, companies and financial institutions have to report on their impacts on and dependencies on ecosystems (EU Corporate Sustainability Reporting Directive). Frankfurt (photo: Pixabay-günther). → *33*

34. Biodiversity protection can be made more binding if it is linked to high-level rights, in some cases at the constitutional level. Social negotiation may result in new legal constructs being created, which will enable legal action to be taken in the future to preserve and promote biodiversity. In this way, a human right to a healthy environment and an intrinsic right of nature could be anchored in the constitution. → F6

35. All social actors can support transformative change: civil society organisations, educational institutions, science, companies, political and administrative players, but also every individual person. Actors in politics and administration have important roles to play in supporting transformative change. Particularly promising are new institutional structures in administration and alliances between different groups of stakeholders in associations and initiatives, as networks or other alliances. → F4, F8

What are the positive impact chains that can reverse the trend?

36. A trend reversal is most likely to be made possible if it is supported by various motivations for promoting biodiversity. Biodiversity can be promoted for its own sake, for its benefits to society or for its cultural significance (see 30). These various motivations can be reinforced by communicating the importance of biodiversity and alternative courses of action. Opportunities for co-determination when designing instruments and measures and a binding legal framework for their implementation are also important. → G1, G2

Figure 21: Biological diversity is part of our cultural heritage: "The Poppy Field near Argenteuil" by the French Impressionist Claude Monet (1840 - 1926) shows the beauty of a species-rich field flora (photo: Adobe Stock). → *36*

37. The most promising approach for biodiversity across all habitats is the extensification of land, water and sea use. This goes hand in hand with an increase in structural diversity and a reduction in nutrient inputs. This creates suitable living conditions for numerous species that are weak in competition and dependent on low-nutrient substrates. Habitat specialists that require certain structures also benefit directly or indirectly. → G3, G4

38. There are proven measures to promote biodiversity. These can be further developed and used in a more targeted way to successfully counteract the loss of biodiversity. These include nature-based solutions across all habitats, an expansion of the protected area system, the restoration of lost habitat types and innovative biodiversity-promoting land use technologies that use biodiversity in a targeted manner to increase and stabilise the performance of our ecosystems. Some measures promote ecosystem services directly, while most are effective indirectly via biodiversity. → G5, G6

Research needs

The comprehensive review of the state of knowledge in the *Faktencheck Artenvielfalt* allows us to recognise knowledge gaps and derive research needs from them. → H1 - 4

The following innovations and measures are needed to better record and explain **biodiversity trends**:

- a large-scale mobilisation of existing monitoring data according to FAIR principles and their harmonised analysis;
- a coherent monitoring design with high representativeness and statistical significance for all habitats;
- the rapid development of automated monitoring methods ready for use;
- the collection and provision of all relevant driver and environmental data, without which cause-and-effect relationships cannot be analysed;
- supplementary experimental approaches to root cause analysis;
- the development of a data assimilation system with which statistical and mechanistic models can make predictions of the development of biodiversity on different time scales. → H1

To better understand the **impact of biodiversity** on us humans, we propose the following steps:

- supplementing monitoring programmes with rapid methods for recording a wide range of ecosystem services;
- strengthening research into cultural ecosystem services, including with digital methods of computational linguistics;
- building a stronger bridge to medical research with cohort studies and experimental approaches in order to understand the impact of biodiversity on human and natural health ("One Health");
- the establishment of an experimental system and the development of innovative technologies to develop new land use systems that use and promote biodiversity in a targeted manner to increase and stabilise performance. → H2

In order to make measures to **promote biodiversity** more efficient, we propose the following elements:

- a systematic follow-up of well-documented measures from previous years in order to record and understand the relevant long-term effects;
- the creation of a comprehensive database based on FAIR principles with evaluation results of implemented measures and an update of these for new measures as a basis for evidence-based nature conservation (analogous to conservationevidence.com);
- the development of a self-evaluation system for private-sector land users as a basis for the performance-based granting of additional funding.
- inter- and transdisciplinary research to establish a multifunctional area mosaic. → H3

The following components are key to **accelerating transformative change**:

- the establishment of real-world laboratories at landscape level, in which land users, social actors and scientists jointly test transformative change;
- the systematic development of accompanying research on transformation processes and the general promotion of methodological development in transformative science;
- research in the field of law on the potential of new legal principles (human right to a healthy environment, intrinsic right of nature);
- strengthening research on the implementation and impact of environmental economic accounts (EIA). → H4

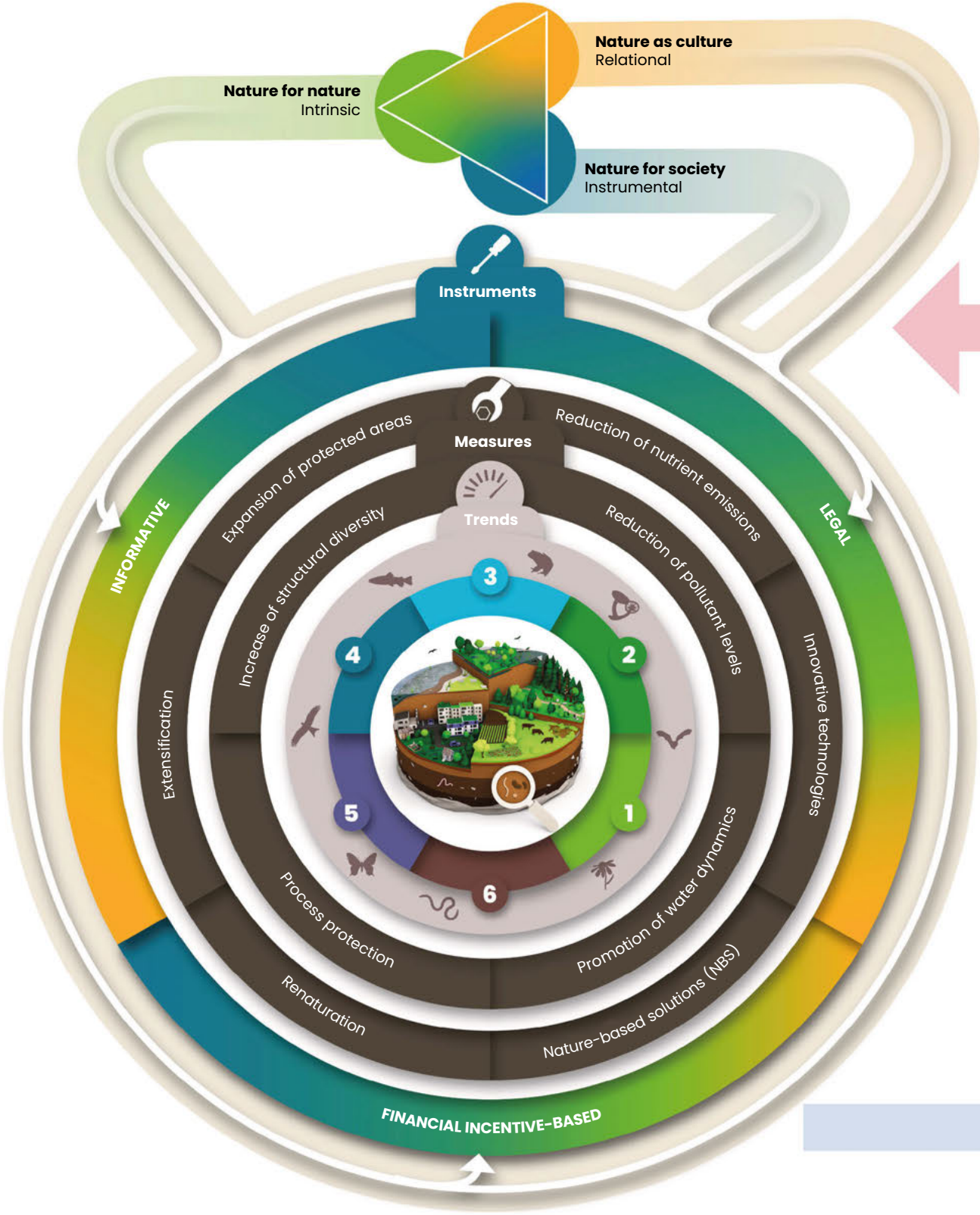


Figure 22: A trend reversal for biodiversity in agricultural and open land (1), forest (2), inland waters and floodplains (3), coast and coastal waters (4), urban areas (5) and soil (6). Left side: biodiversity is influenced by the interplay of various social processes. Motivated by the central rationales of "nature for nature", "nature for society" and "nature as culture", informational, financially incentivised and legal instruments have an impact on trends in biodiversity in all habitats through a wide range of measures. Overall, this can lead to a trend reversal towards a reduction in negative biodiversity developments (examples on the right, red) and an increase in positive biodiversity developments (examples on the right, blue).

Photos: Helge Bruelheide (red 1, 2; blue 1, 2, 3), Niteshift, CC BY-SA 3.0 via Wikimedia Commons (red 3), Jörg Freyhof (red 5), Dorothee Hodapp (red 4), Pixabay (red 6, blue 4), Botanical Garden of Leipzig University (blue 5, 6).

1

69%

of open land biotope types are considered to be endangered in the long term. 80% of these are still in decline, e.g., species-rich fields, active raised bogs and grassland in wet to damp locations.

2

5%

increased tree mortality from 2018 to April 2021 due to drought and heat. If fungal diseases and species like the bark beetle are introduced, there is a risk of major losses.

3

200.000

transverse structures and 7,000 small hydropower plants are restricting the continuity of watercourses, with consequences for fish, insects, small crustaceans and aquatic plants.

4

9,30%

of the seabed habitat types in the North Sea are considered to have been completely destroyed. These include seagrass beds on littoral sediments and European oyster banks.

5

4,039 km²

were newly sealed between 1992 and 2021. Remaining areas are increasingly isolated, with negative effects above all for amphibians, dragonflies, reptiles, wild bees and grasshoppers.

6

30,000 tonnes

of plant protection products are applied every year. These can reach high concentrations in the soil and damage soil organisms, pollinators and other beneficial organisms.

1

13,40%

was the proportion of agricultural and open land areas with high structural and biological diversity in 2022. These areas provide important habitats for open land species.

2

18%

deadwood was added per hectare of forest between 2002 and 2012 through active enrichment and disturbance events. A third of forest species is dependent on deadwood.

3

7,000 hectares

over the past 20 years, of floodplain areas have been reclaimed due to renaturation, which has benefitted typical floodplain communities.

4

2290

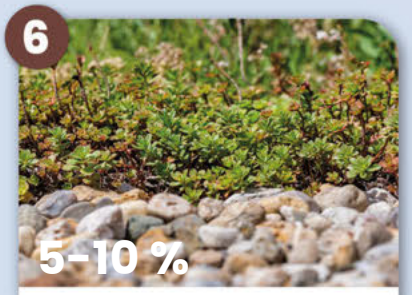
adult grey seals were counted in the North Sea in 2022. The populations are slowly recovering after hunting was banned, which had almost wiped them out in the 1980s.

5

96%

of the almost 400 municipalities surveyed stated that they had created urban flowering areas. Flowering areas from local seeds provide food for insects.

6



5-10 %

of newly constructed roof surfaces are greened. Green roofs create habitats for snails, spiders, cicadas, beetles and other soil-dwelling insects.

»A highly impressive reference work that we urgently need in order to take practical and effective measures to conserve biodiversity in Germany.«

Volker Mosbrugger, Senckenberg Society

The state of nature is deteriorating worldwide – and with it its vital contributions for us humans. This is what the global assessment of the World Biodiversity Council IPBES found. Is there a biodiversity crisis here in Germany, too? And if so, what are the reasons and what can we do about it?

These questions are explored by 150 authors from 75 institutions and organisations in the ›Faktencheck Artenvielfalt‹. Biodiversity is also declining on our doorstep. Important habitats are disappearing, formerly common species are becoming rare, many ecosystems are becoming impoverished and subject to rapid change. The driving forces behind this – cleared landscapes, intensive land use, inputs of contaminants, climate change – are caused by us humans.

But there is also good news: Being the main cause, we have the power to reverse this trend ourselves. The ›Faktencheck Artenvielfalt‹ shows encouraging examples and analyses what works in practice and, more importantly, under what conditions we are willing to act for biodiversity. A societal transformation towards an economy with and not against biodiversity is necessary – and possible.

This summary (ISBN 978-3-98726-175-6) contains the most important findings for societal decision making from the book ›Faktencheck Artenvielfalt‹ (ISBN 978-3-98726-473-3) in 38 key statements.

Faktencheck Artenvielfalt
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