



The Biodiversity Imperative for Business

Preserving the Foundations of Our Well-Being

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»There is no Planet B«

These were the words the French President Emmanuel Macron used in 2018 as he urged the United States Congress to step up its efforts in combating climate change. They have become a message featured on countless signs held up by striking schoolchildren at Fridays for Future protests. Yet the realization that the Earth's resources are limited and that we, as a species, can only thrive if nature thrives is not new. As early as 1972, the Club of Rome warned of the consequences unsustainable development would have for our environment; that same year marked the beginning of international environmental politics with the United Nations Conference on the Human Environment in Stockholm. Outrage over the hunting of migratory birds led to the creation of the EU Birds Directive in 1979, and scientific warnings resulted in a ban on ozone-destroying CFCs by 2000. Since then, a host of innovations and regulations, e.g., regarding energy efficiency as well as air and water quality, have shown how technological progress



Jörg-Andreas Krüger (left) and Torsten Kurth

can help benefit the environment. And yet so far, the measures taken were not sufficient to keep pace with the far-reaching environmental changes happening on our planet.

Over the last six decades, the Earth has changed more rapidly than at any other time in history. Striving to meet the growing demands of a globally connected population at the lowest possible cost, we have tolerated the rising pollution and exploitation of the environment. Now the prospect of the Earth overheating and biodiversity declining has gone from being a warning issued by scientists to real-life events we witness every day—which constantly present new challenges to our economy and societies. With every animal and plant species that is lost (often even unnoticed), we risk destabilizing the planet's ecosystems—and with them, the foundations of economic activity and the livelihoods of future generations. In recent years, biodiversity loss has rapidly moved up the agendas of global decision-makers to become one of their major concerns, along with climate change. Now is the time to turn insights and targets into real progress.

The preservation and restoration of biodiversity are the cornerstones of a sustainable and resilient world. Biodiversity is our greatest ally in the battle against the climate crisis and provides us with essential services free of charge: Peatlands and seagrass beds capture and store greenhouse gases; species-rich forests help retain precious rainwater in the landscape; restored rivers can slow down flood surges. A wealth of diversity in the natural world also makes it possible for us to produce food, clothing, and medication. The more biodiversity thrives, the better for our lives – and for the economy. After all, most sectors are heavily reliant on the services and natural resources biodiversity offers.

This study shows that economic activity and biodiversity preservation do not need to contradict each other: By taking future-oriented action, one can benefit the other. The economy plays a crucial role in our efforts to protect and restore biodiversity—and businesses have proven time and again that they are capable of rapid environmental reform. Today, for example, the chemical industry is investing in biodiversity-safe products, and numerous construction projects are looking at ways to integrate nature and technology. Nonetheless, a biodiversity-friendly economy also requires the backing of society – and support from governments in the form of reliable, fair market conditions and economic incentives.

Our aim with this report—a joint project between the Boston Consulting Group (BCG) and Germany's Nature and Biodiversity Conservation Union (NABU, the Partner of BirdLife International in Germany)—is to highlight the importance of biodiversity as the indispensable foundation of the global economy and human well-being, and to invite businesses, politicians, and society to add their essential contributions. We hope that our suggestions will inspire collaborative solutions that help to harmonize economic prosperity with the integrity of the natural world, and thus benefit global societies. It is only by taking rapid, collective, and decisive action that we will be able to ensure the long-term well-being of future generations.

Torsten Kurth

BCG managing director and senior partner

Jörg-Andreas Krüger

NABU president



Biodiversity loss and climate change ...



... are the most important challenges threatening people's lives and well-being today. We are destroying and consuming nature at an unprecedented rate, threatening the survival of a million species—plant and animal—without realising this is also putting our own species at risk.

The root cause of biodiversity loss is a 'systems' failure, arising from the way that biodiversity is treated in economic systems. If we are to halt the accelerated loss of the biodiversity upon which natural systems, society and our economies depend, transformative change is required.

We will not fully deliver our development goals unless biodiversity is properly and fully integrated into public and private decision-making. Transformational change will require an all society approach with citizens, governments, and business working together to ensure there is cross-sectoral harmonisation of biodiversity-related policies, implementation, and actions.

Importantly we must see a redirection of financial flows away from activities that harm biodiversity towards those that restore, conserve, and manage it sustainably. This includes transforming our key productive sectors such as agriculture, forestry, fisheries, mining, and infrastructure.

We must recognise that nature is at the heart of the solution to the challenges we face. Urgent, joined-up policy and action to tackle both the climate and biodiversity crises is key—driving the rapid, just transition to nature-sensitive renewable energy, while promoting and developing nature-based solutions that support biodiversity while providing climate change mitigation and adaptation. Integrated policy, practice, and finance is critical if we are to meet global goals and targets on nature, climate, and sustainable development by 2030.

The Biodiversity Imperative for Business is an informative guide for collaborative action as we have entered our 'last decade of opportunity' for meaningful action and transformative change. This comprehensive analysis examines why biodiversity is essential for our well-being and explains the economic value it provides; the root causes of its loss; and how we can address this through a systemic approach.

Business has a critical role to play in achieving this across the whole value chain. We need to move from biodiversity-friendly / sustainable practices being "best practice", to "normal practice" to "required practice" and get smarter in seeing how the private sector, civil society, and the financial sector can work with governments to achieve this and achieve far-reaching and enduring impact at a local to global scale.

As COVID-19 reminds us, the destruction of nature harms people's survival and wellbeing directly. Lest we forget, we are part of nature, and we need a healthy planet to survive together. A post-COVID recovery must be a green recovery with the human right to a healthy natural environment at its core.

Let's join forces to make that real and lasting difference.

Patricia Zurita

CEO, BirdLife International



Executive Summary

Biodiversity, understood as the diversity of ecosystems, species, and genes, is at the core of human well-being. Its services allow our economy to thrive and ensure the livelihood of billions of people. Yet, the rate of biodiversity decline has never been so fast: Around one million species are facing extinction within the coming decades, and every year over \$6 trillion of nature's economic benefits are lost.

In response to the growing crisis, NABU and BCG conducted a comprehensive analysis to answer three questions:

1. Why is biodiversity essential for our well-being, and what economic value does it provide?
2. What are the root causes of biodiversity loss?
3. How can biodiversity loss be stopped?

Among our findings:

Biodiversity provides over \$170 trillion in yearly benefits on top of its inherent value. Firstly, a healthy nature holds enormous, intrinsic value and deserves to be protected for its own sake and for future generations. Secondly, ecosystems provide valuable services to humans, most importantly in the form of fertile soil, the regulation of the climate, and genetic resources for medicinal use, as well as cultural offerings for our recreation. The economic benefits of these ecosystem services are estimated at an annual value of \$170–190 trillion, equivalent to double the value of global GDP. This value demonstrates the imperative to preserve biodiversity for the sake of all human well-being, including local communities but also global businesses and consumers.

The root causes of biodiversity loss arise from economic activities. Driven by evolving patterns of consumption, production, and trade, activities all along the economic value chain exert enormous pressure on biodiversity: Farming, forestry, mining, industrial production, and infrastructure expansion currently cause almost 60% of overall pressure. For example, infrastructure expansion, while crucial for economic and social development, may fragment habitats and affect species' survival if projects do not provide for adequate relocation or restoration. In many cases, a possible balanced coexistence of biodiversity and business has been impeded by target conflicts inherent to our economic system, which is based on the exploitation of land and natural resources. In consequence, preservation requires systemic change towards an internalization of the value of biodiversity in economic decisions.



Biodiversity and climate change are strongly interlinked. Many ecosystems, such as forests, grasslands, and peatlands, store carbon on a massive scale and can make a substantial contribution to combating climate change. However, ecosystem degradation causes the release of carbon into the atmosphere; and in turn, climate change leads to further biodiversity decline – underlining the urgency of acting on both environmental crises.

A systemic approach to change is needed. Biodiversity loss cannot be addressed with the same tools as climate change: There is no single method for measurement and no universal solution. Rather, biodiversity is local and does not allow for one-size-fits-all solutions, as there is considerable variation in ecosystems, their species compositions, and processes. Resilience comes from diverse, connected land- and seascapes, where native species can exist and interact. The following six levers should guide stakeholders to developing a systemic biodiversity approach as well as setting and delivering on biodiversity targets:

- Since large shares of the Earth’s surface are in human use, **integrative land use models** are required at least as much as **protection and restoration measures**.
- **Regulation and economic incentives** need to set the framework and create a level playing field for all stakeholders.
- Companies should engage in **voluntary commitments** as well as measuring and transparently disclosing their biodiversity impact.
- **Innovation and collaboration** are needed to develop biodiversity-friendly solutions.
- **Information and education campaigns** for the broader public are essential to promoting an understanding of biodiversity’s state and needs.
- Local stakeholders such as land users need to be **enabled to act** on biodiversity preservation.

The evidence is clear: To maintain a stable and resilient planet, mitigating climate change and reversing the biodiversity crisis are two sides of the same coin and must be an imperative for businesses. The last years have witnessed an upsurge in public awareness, regulatory activity, and engagement among diverse stakeholders. Now is the time to take these initiatives to a coordinated, integrative level and establish systems that allow our economy and nature to grow together.

Each of us has a responsibility to act now. Collectively, we can preserve our endangered natural spaces to ensure a sustainable future for generations to come.



1. The Biodiversity Movement Is Picking Up

1.1 The Urgency of Addressing Biodiversity Loss

In recent centuries, humans began directly shaping the planet's ecosystems, marking the onset of the Anthropocene era. During the same period, nature started to lose major species, biotopes, and habitats. Nowadays, biodiversity is declining faster than at any other point in human history. As we harness the Earth to support a rapidly growing population and its need for food, housing, clothing, transport, and connectivity, we exploit and deplete the planet's natural capital.

Economic activities threaten the intactness and functionality of ecosystems through the conversion and intensive use of land, overexploitation of resources, or pollution from industrial enterprises. Science confirms that we have now entered the sixth global mass extinction, the first such event since the extinction of the dinosaurs and the only one caused by humankind.¹ Natural wetlands, one of the most diverse terrestrial ecosystems, have declined by 85% since 1970.² In the past 50 years alone, the world has lost 60% of its vertebrates,³ leaving the total biomass of all wild mammals and birds now at less than 10% of the total biomass of livestock for food production.⁴ Finally, 75% of total flying insect biomass in protected areas in Germany has been wiped out in the past three decades⁵—a development with the potential for far-reaching consequences due to the key role of insects in the world's complex food webs. Globally, scientists estimate that over 40% of insects are threatened with extinction.⁶

These changes are indicative of our gradual crossing of the planetary boundaries, representing nine environmental indicators of global systemic stability and resilience.⁷ As is commonly known, the Earth has crossed the boundary on climate change and is drifting towards the high-risk zone in terms of more than 2° C of warming. Less known is the fact that the Earth has long since entered the high-risk zone on the intactness of our biosphere. The gradual change in natural structures and decline of key ecosystems and species puts enormous pressure on a planet that is already out of balance—and, just like for climate change, will probably cause abrupt and irreversible changes in natural processes with potentially catastrophic consequences.

But biodiversity is not just about systemic stability. The decline of natural ecosystems further entails a loss of their services, including essential functions for economic development and public welfare. The majority of global economic value chains is founded on nature's provisioning services, such as of food or raw material. Meanwhile, functions like waste treatment, disaster mitigation, or water purification are essential to the stability and livelihood of many communities. Our results estimate the losses from ecosystem service at over \$6 trillion per year, a value exceeding the GDP of all countries except the US and China (see chapter 2.4 and appendix). Biodiversity preservation is an imperative act for maintaining the conditions that allow societies and economies to thrive. Yet, while the urgency of addressing biodiversity loss has been known by scientists for long, societal reaction has been slow: The momentum to act on biodiversity has been building up only in recent years (see figure 1).

1.2 Rising Global Momentum

While biodiversity loss was long poorly understood and overshadowed by other environmental and social challenges, recent years have seen rising public and scientific attention. In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) published its seminal *Global Assessment Report*, calling out all sectors for transformational change to halt biodiversity loss. In 2020, despite a global focus on COVID-19, the perceived urgency of biodiversity loss by sustainability experts worldwide has risen to 86%—almost equal to that of climate change.⁸ Recently, the Stockholm Resilience Centre suggested classifying the four environmental *Sustainable Development Goals* as the foundation for all other social and economic goals.⁹ Initiatives to counter biodiversity loss can now be found across regulatory, civil society, and business spheres.

Rising **regulatory ambitions** to set the course for biodiversity preservation have led to an acceleration in framework development. In 2010, the UN Convention on Biological Diversity (CBD) formulated the *Aichi Targets*, outlining achievements on biodiversity's major frontiers to be made by 2020.¹⁰ Yet, most *Aichi Targets* remain unmet due to poor national implementation, the lack of need-based financial resources, and insufficient incentives to address the economic drivers of biodiversity decline. In the face of scientific clarity on the urgency to act and spreading public awareness, the CBD's post-2020 framework, which is expected soon, is set to feature greater ambitions, more actionable targets, and binding elements for member states.

The EU has already started to intensify its preservation efforts. A set of strict species protection rules, and the *Natura 2000* network are legally based on the EU Birds and Habitats Directives. *Natura 2000* now encompasses protected areas on 18% of land and 6% of sea area, making it the largest network of protected areas worldwide.¹¹ The first fruits of past efforts include spectacular returns of large carnivores and birds, such as wolves, cranes, or white-tailed eagles.¹² The new *EU Biodiversity and Farm to Fork Strategies*¹³ within the scope of the European Green Deal take up this success and demand that member states intensify their protection and restoration efforts, expand biodiversity-sparing land use models, reduce the excessive use of chemicals in agriculture, and adopt circular economy principles. Binding directives, including fines if targets are not met, are expected and required to follow soon.

Civil society is likewise starting to recognize the dangers of biodiversity loss. According to a recent survey, biodiversity preservation is perceived as the second-most urgent sustainability challenge, closely behind climate change and ahead of issues like water safety, waste, and air pollution.⁸ Public campaigns have contributed to raising awareness and tabling these discussions. For example, the 2015 *Nature Alert campaign* brought together environmental associations and EU environmental ministers to combat the planned weakening of the EU Nature Conservation Directives.¹⁴ Over 500,000 signatures were collected, prompting the EU Commission to maintain and strengthen the directives.¹⁵ Other recent campaigns have included bee saving initiatives, action against big game hunting, and boycotts against brands linked to deforestation. As governments plan their recovery following the COVID-19 crisis, the public is now demanding the economy to “build back better” and incorporate green stimulus packages and nature conservation objectives.

Finally, the **corporate world** is ramping up its efforts. For example, in the *One Planet Business for Biodiversity (OP2B)* coalition, more than 20 international, cross-sectorial companies join forces to help preserve and restore biodiversity in agriculture in three areas of focus: scaling up regenerative agricultural practices to protect soil health; diversifying the production portfolio to boost cultivated biodiversity; and protecting and restoring high-value ecosystems.¹⁶ In the *Business for Nature* initiative, firms have come together with nongovernmental organizations (NGOs) to influence policy-making and introduce nature to economic decision-making.¹⁷ The World Economic Forum, meanwhile, emphasizes biodiversity loss as a major systemic risk and investigates how business can contribute to preservation.¹⁸ Beyond the loss of nature’s provisioning services, firms face risks from increasing regulation and critical perception among consumers and investors. Those not complying with expectations may be subject to fines, sanctions, declining revenues, and increasing funding costs.

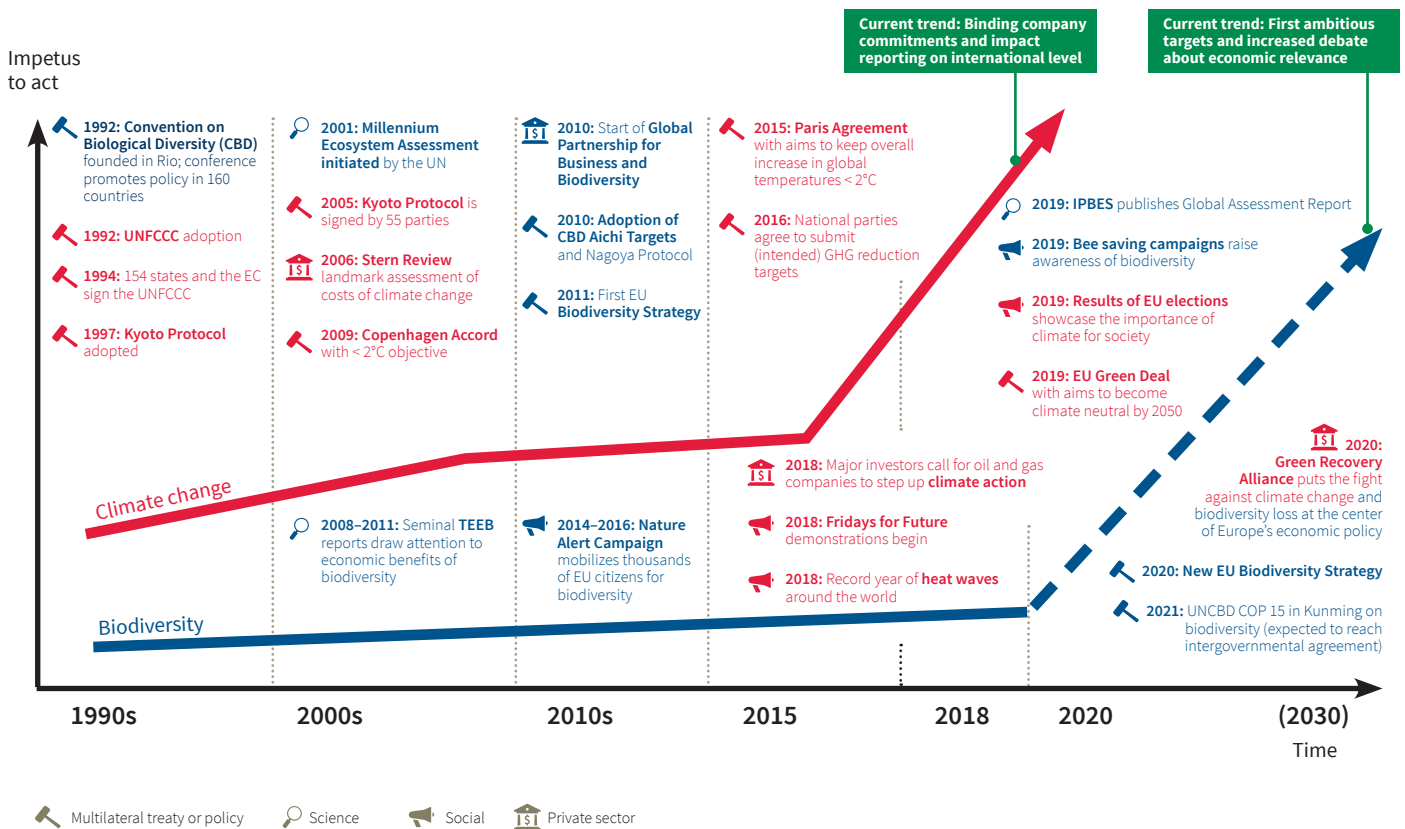


Figure 1: Historical impetus on climate change vs. biodiversity. Source: BCG

In short, biodiversity is on the verge of being mainstreamed into political agendas and corporate strategy.¹⁹ Figure 1 showcases the trajectories of climate change and biodiversity, illustrating how catalytic events across society can trigger this mainstreaming. The 2015 Paris Agreement set a clear, global target and gained national commitments. Subsequently, increasing visibility of global warming along with scientists’ resounding warnings sparked public movements like *Fridays for Future*, which are said to have influenced the 2019 European elections. In turn, businesses have been facing significant pressure to reduce their climate impact, as exemplified by repeated calls from major investor groups.²⁰ Given the described endeavors, biodiversity is now set to experience a similar trajectory. In the following chapters, we provide an overview of biodiversity’s dimensions and the pressures it faces, analyze the impact of economic activities, and outline systemic levers to address biodiversity loss.

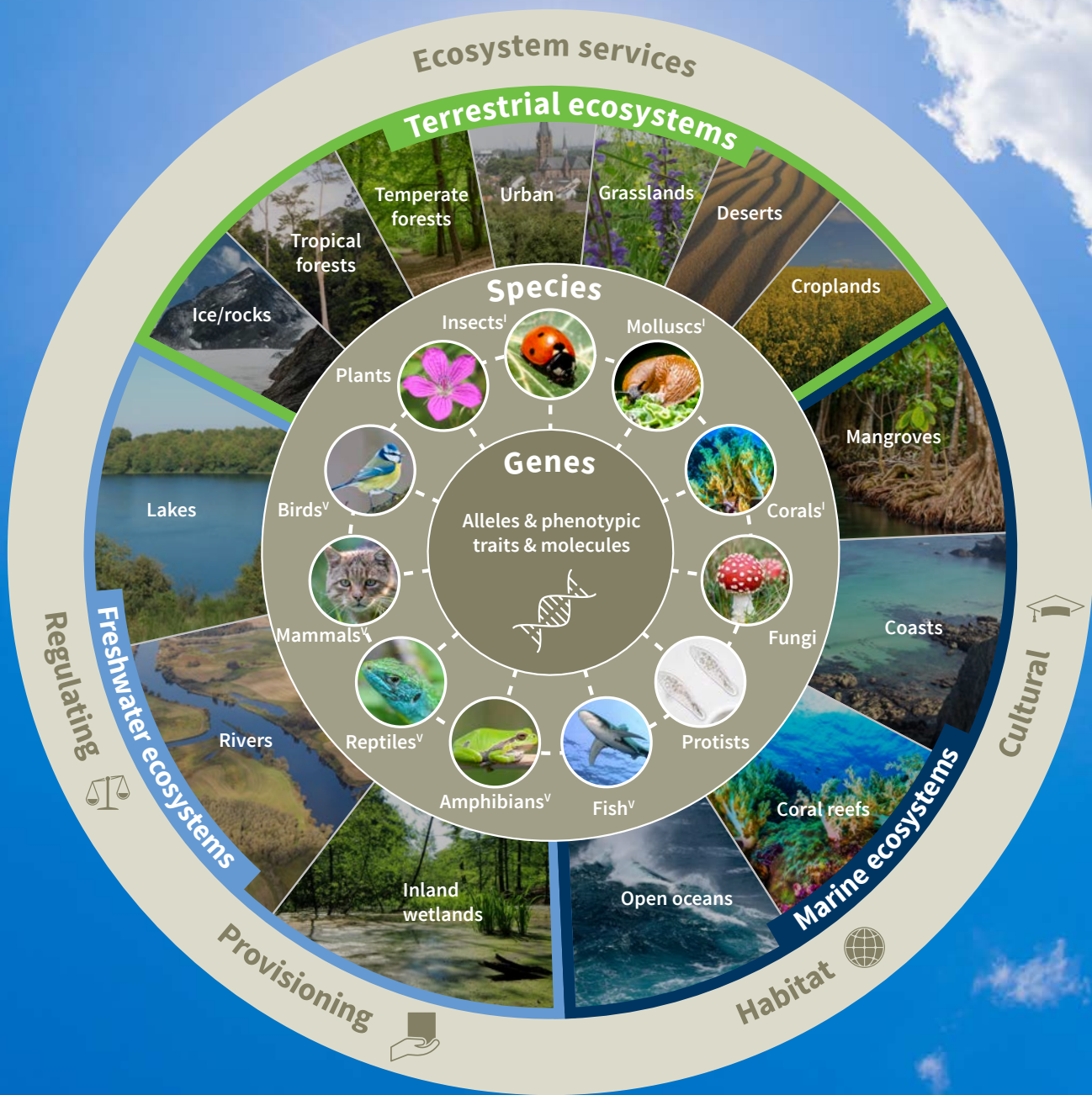


Figure 2: Definition of biodiversity.
 Note: Species are classified as plants, vertebrate animals (marked with „V“), invertebrate animals (marked with „I“), fungi, and protists.
 Source: BCG

2. Understanding the Enormous Value of Biodiversity

The difficulty in understanding biodiversity in all its interconnected facets has led to the broad belief that its decline mostly concerns the extinction of species. This has resulted in somewhat limited involvement of many businesses and consumers in the topic and a general lack of action. In consequence, a simplified yet comprehensive narrative is necessary to convey the economic relevance of biodiversity and help all stakeholders identify starting points for action to preserve biodiversity. This chapter explains biodiversity along five questions: *What is biodiversity? Where does it occur? Who is affected? Why should we care?* and *What is at risk?*

2.1 What Is Biodiversity, and Where Does It Occur?

Figure 2 depicts biodiversity in all its levels and dimensions. The “biodiversity circle” must be considered from the inside out: From the molecular level to the macroenvironmental level, biodiversity encompasses the variability of genes, the number, distinctiveness, and spatial distribution of species, and the diversity of ecosystems. The interplay between all these elements enables ecosystem services through nature’s regulating, provisioning, habitat providing, and cultural functions. In turn, altering just one element inside the circle may curtail those functions.

- At the most granular level, biodiversity denotes **genetic variability**, meaning the distinctiveness of genes within a species or breed.²¹ Among other things, genetic variability defines the adaptability of a species to environmental changes and threats. In 2010, the CBD adopted the *Nagoya Protocol*²² to support biodiversity preservation through an equitable global sharing of genetic resources.
- The most frequently mentioned level of biodiversity is the **species** level,²³ illustrating the variety of plants, animals, and microorganisms on our planet. The total number of species on Earth is unknown – with the best current estimate being 8.7 million.²⁴ By 2019, the International Union for Conservation of Nature (IUCN) has identified and classified 112,400 species, including 38,600 plants (35%), 22,700 invertebrates (20%), and 50,800 vertebrates (45%).²⁵

- At the macro level, biodiversity in **ecosystems** describes the interaction of plants, animals, and microorganisms with each other and their nonliving environment. The health of an ecosystem is often measured in terms of its area or its species abundance. The distinctiveness and connectivity of different ecosystems, and thus habitats, is strongly linked to both the abundance of species and the global value of resulting ecosystem services.

By its very nature, biodiversity is a local phenomenon. Ecosystems evolve from an interplay of specific conditions, with regional temperature, rainfall, and species interaction all playing important roles. Still, biodiversity is highly interconnected across ecosystems, and small, local changes can eventually trigger major global shifts. The Earth hosts three major types of ecosystems with a wide range of local manifestations: terrestrial, freshwater, and marine. All of them are in constant evolution and highly sensitive to external conditions.

- **Marine ecosystems** are the largest by area, covering 70.5% of the Earth’s surface. They include open oceans, coastlines, mangroves, and coral reefs. Together, they have a large impact on the global climate, the amount and frequency of precipitation, and humidity flows.
- **Terrestrial ecosystems** cover 29% of the Earth’s surface and include tropical, temperate, and boreal forests, grasslands, including heath and bushes, deserts, ice, and rock areas, as well as human-made croplands and urban ecosystems. These ecosystems are dependent on precipitation and freshwater flows to maintain the abundance of species.
- **Freshwater ecosystems** constitute the smallest share. Despite making up just 0.5% of the Earth’s surface area, freshwater ecosystems such as inland wetlands, peatlands, lakes, and rivers are extremely relevant and delicate. Freshwater ecosystems provide highly valuable ecosystem services and often connect terrestrial and marine ecosystems, thereby exerting a systemic influence.

2.2 Who Are the Stakeholders?

While biodiversity inherently provides the livelihood and foundation for all humankind, some socio-economic stakeholders most directly affect or suffer from the degradation of natural resources, while others act as enablers of potential change, as shown in figure 3. For a just transition to a biodiversity-safe future, all these societal stakeholders must be considered by establishing social safeguards and particularly respecting the rights of local communities and indigenous peoples. The specific opportunities to act and the role of the enablers are elaborated in detail in chapter 5.3.



Figure 3: Overview of stakeholders affected and involved in biodiversity.
Source: BCG

Companies can play an active role in biodiversity preservation due to their direct impact and dependency on biodiversity. On the one hand, through resource extraction, cultivation, and industrial activities, companies exert pressure on biodiversity. On the other, particularly goods-producing industry players are most dependent on natural resources for their supply of raw materials and the functioning of their supply chains.

Citizens as consumers depend on and benefit from nature's provisioning services. Yet, through demand and waste, they, directly and indirectly, impact ecosystems and alter nature's ability to provide services in the future. Furthermore, local communities and indigenous peoples often depend directly on utilizing nature's abundance for their own needs and economic sustenance. For example, in Africa, around 80% of people are dependent on fuelwood as their sole source of energy.²¹ In turn, indigenous communities often help to protect important natural areas; for instance, by owning and managing 25% of global land area.²

2.3 What Is the Value of Biodiversity?

» Nature is a capital from which humans live—it must be preserved. Not just for the sake of nature but for the economic value it provides to people.

Prof. Volker Mosbrugger, Managing Director, Senckenberg Society for Nature Research

Humans are part of nature and are deeply connected to the interactions of species in local and global ecosystems. For this reason, biodiversity cannot be considered a remote and separate entity. On the one hand, nature deserves to be protected for its intrinsic value, independent of the value it provides to us humans. Nature also provides values that are difficult to measure: Everyone has a sense of what nature and access to natural environments mean to them. This translates to unquantifiable values in terms of spiritual peace, well-being, and enjoyment.

On the other hand, humanity thrives thanks to the functioning of nature and its interconnections. Purified air, clean drinking water, plentiful food, and access to medical supplies are fundamental to human survival and quality of life. Over 75% of global food crops, including fruits and vegetables, depend on animal pollination, 70% of all cancer drugs are derived from or inspired by nature, and 4 billion people rely directly on natural medicines and genetic resources for health care.² These more tangible benefits of healthy and functioning biodiversity are typically denoted as ecosystem services and clustered in four groups, shown in figure 4: provisioning of resources, habitat creation and maintenance, environmental regulation, and cultural support and inspiration. For most ecosystem services, a monetary value can be estimated deriving from their share in the development of goods and services or the damage that would be incurred without them.

As part of this study, we conducted a monetary valuation of ecosystem services. We built on the *Ecosystem Service Value Database* developed by the research group around R. Costanza (2014)²⁶ and R. de Groot (2012)²⁷ for the international initiative *The Economics of Ecosystems and Biodiversity (TEEB)* and updated the computations to reflect current macroeconomic conditions. For the evaluation of forest ecosystems, we built upon BCG's 2020 study *The Staggering Value of Forests—and How to Save Them*, which quantified the climate-regulatory, environmental, commercial, and social value of global forests.²⁸ Details can be found in the appendix.

We arrive at an economic benefit of **\$170–190 trillion annually**—comparable to twice the world's current GDP.²⁹ This substantial monetary value illustrates the dependence of economic development and social well-being on environmental integrity. Still, it is important to note that only a fraction of ecosystem services can actually be translated to economic terms, indicating that our estimates represent a lower bound.



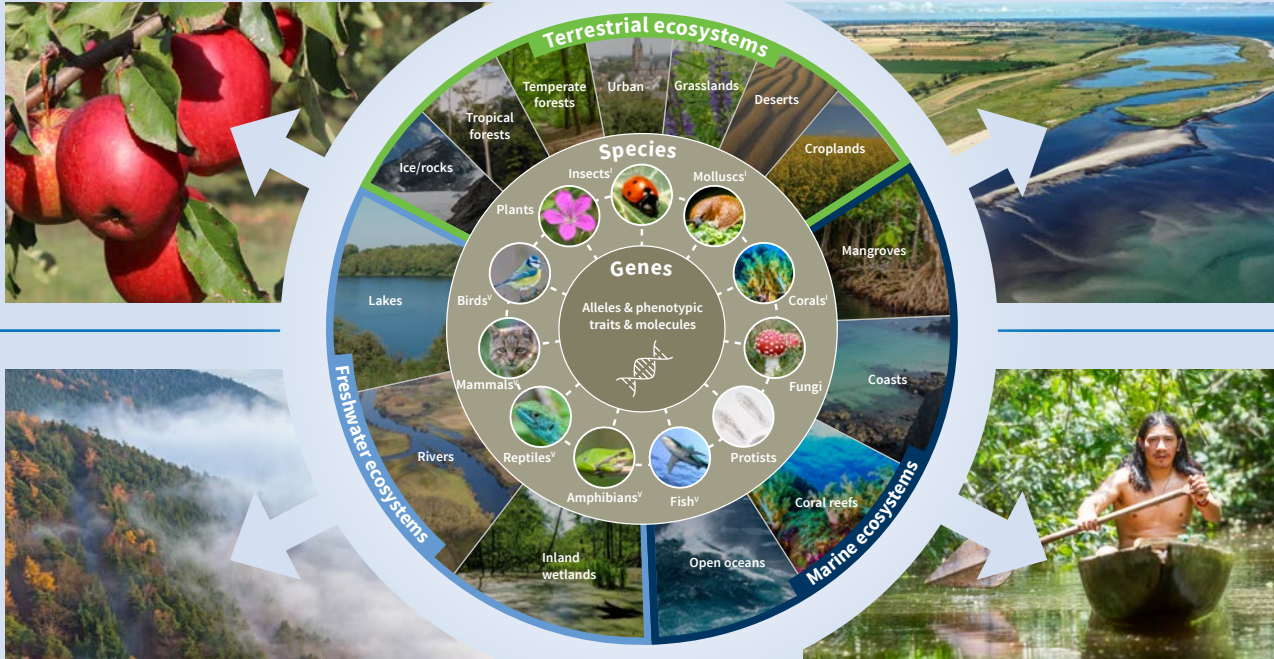
Provisioning

- Food
- Genetic and medical resources
- Raw materials (incl. freshwater)

Habitat



- Refugia and nursery service
- Soil formation



- Climate regulation
- Waste treatment
- Erosion prevention
- Air quality
- Nutrient cycling
- Biological control
- Pollination
- Water regulation
- Disturbance moderation

- Recreation
- Cultural heritage
- Spiritual values
- Education and inspiration



Regulating

Cultural



Figure 4: Ecosystem services offered by functioning biodiversity.
Source: IPBES (2019); BCG

The value of ecosystem services is split disproportionately across the four types (see figure 5).

- **Regulating services** account for an extraordinary 65% of total ecosystem service value. They provide many essential functions for environmental stability by regulating our climate, treating our water, recycling nutrients, preventing soil erosion, and moderating floods. We evaluate the opportunity costs that society would incur for their artificial substitution in order to maintain communal livelihoods and avoid disasters. Thus far, regulating services are rarely accounted for in our fiscal systems, still fairly underexplored, and little understood.
- **Cultural services** involve the recreational, heritage, spiritual and educational functions of ecosystems. Thus far, only the recreational function – which is essential to the tourism industry – has been quantified in monetary terms, resulting in a share of 18% in total ecosystem service value. Including the other functions, the share of cultural services is likely even higher.

- **Habitat services** provide around 10% of the monetary value of ecosystem services. Habitat services denote the ability of nature to provide refugia and nursery grounds for animals and plants, and the formation of humus-rich, fertile soils, which is essential for agriculture. On top comes the invaluable function of enabling plant and animal populations to thrive.
- **Provisioning services**, such as the supply of food and timber, only provide about 7% of total ecosystem service value. This mirrors the fact that the net value provided by nature only accounts for a fraction of current market prices. The difference is the value added by economic activities like cultivation or raw material conversion, which are not counted when evaluating provisioning ecosystem services. Worth noting is the provision of genetic and medical resources whose annual global benefits are estimated at \$4 trillion, demonstrating society’s reliance on nature for physical health. This is mirrored by the *Nagoya Protocol*, which was adopted by CBD to establish the conditions for an equitable global sharing of genetic resources.

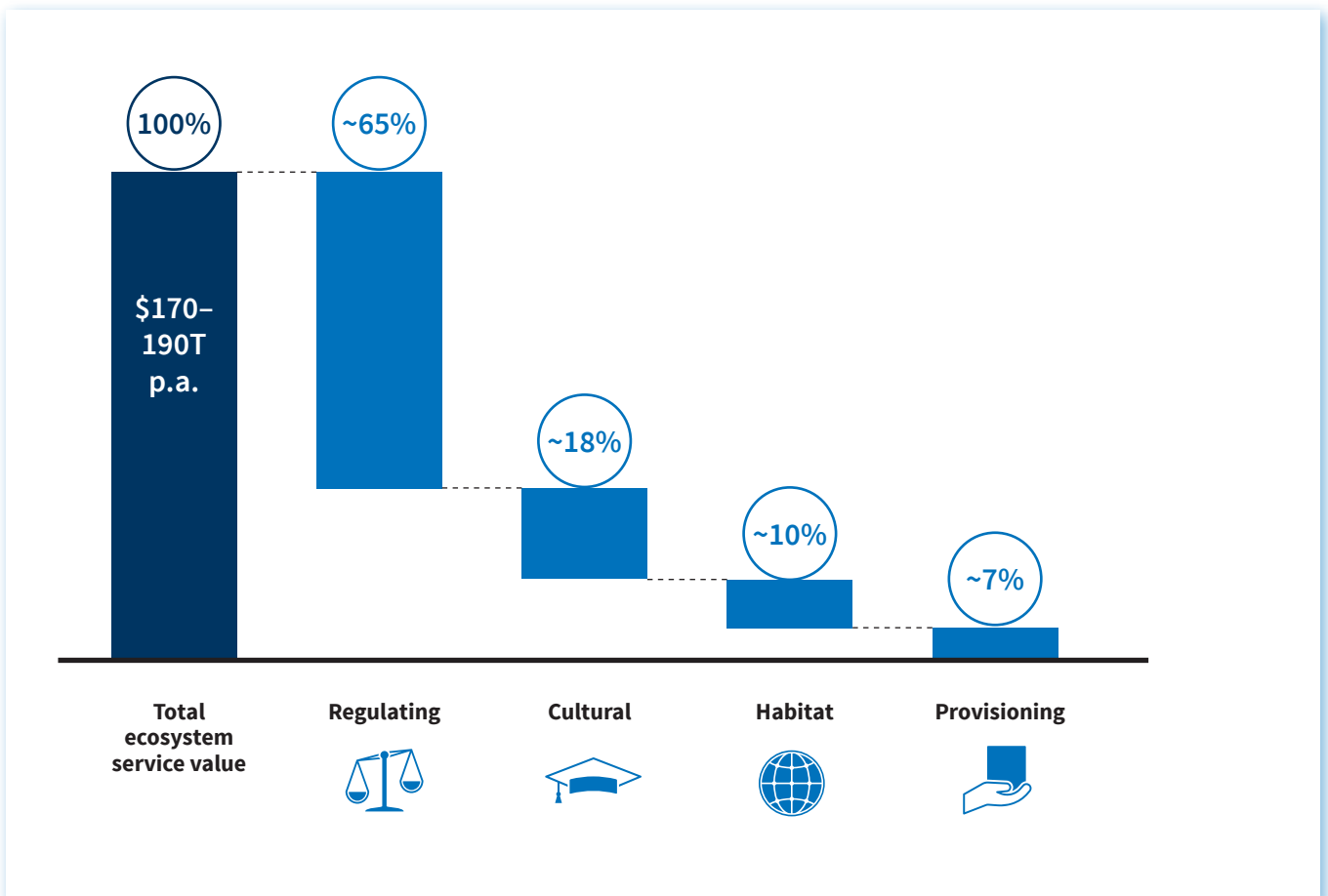


Figure 5: Value per ecosystem service group.
 Source: BCG analysis based on Costanza et al. (2014) and de Groot et al. (2012)

To some extent, the ecosystem service value of global ecosystems correlates with their size. Marine ecosystems provide 68% of the total value, including climate regulation by open oceans, water treatment by mangroves, and erosion prevention by coastal ecosystems. Terrestrial ecosystems provide 29%, mostly through climate regulation, waste treatment, and erosion prevention. Freshwater ecosystems contribute only 3% in monetary terms, yet, their regulating, habitat-providing, or nourishing functions are often indispensable to neighboring ecosystems and local communities.

While making use of nature’s services, it is important to understand the inherent trade-offs between them. Earning economic benefits from provisioning services by extracting food or raw materials, if not done in a sustainable way, may involve the degradation of ecosystems and compromise other

functions.³⁰ For example, harvesting wood with unsustainable forest management practices may reduce a forest's ability to sequester carbon, provide habitats for animals, or recycle waste and nutrients. These functions cannot always be artificially restored to their original level. Put another way, provisioning services often depend on intact regulating and habitat services. On the other hand, if forests are sustainably managed, forestry practices can go hand in hand with the protection of the ecosystems' regulatory and supportive functions. In consequence, the preservation of nature's services requires carefully planned, regional ecosystem management that considers all unique ecosystem benefits and their trade-offs and interrelations with each other.

2.4 Why Does Biodiversity Loss Matter?

Despite the benefits humans draw from nature, our own human activities are largely responsible for the destruction of ecosystems, loss of ecosystem services and decline of species and genetic variability. This decline is happening faster than at any other time in human history, threatening planetary stability. The risks of biodiversity loss manifest themselves in three major ways.

Most directly, human intervention has affected the **extent of ecosystems**. Two-thirds of global marine and 75% of terrestrial surface area are significantly affected or altered by human activities, but the greatest change can be seen in the smallest ecosystem, with 85% of freshwater ecosystems facing decline.² Despite these developments, only 15% of the terrestrial and freshwater area, 10% of the national marine area, and 4% of oceans are covered by protected areas.³¹ Moreover, existing protected areas are neither fully ecologically representative nor sufficiently managed and monitored.

From an economic perspective, the reduced functionality of ecosystems due to human intervention causes annual **losses of ecosystem services** estimated at \$6–30 trillion (representing 3–15% of total ecosystem service value, see appendix for methodology). That external cost is carried by public and private stakeholders alike. Communities may, for example, face higher investments for water purification, waste treatment, and disaster prevention if key regulating ecosystems are lost. Businesses may be subject to higher raw material costs due to reduced abundance and accessibility or the need to substitute ecosystem functions; for example, by using chemical agents in food cultivation. Due to accelerating biodiversity decline, the cost of inaction is likely to grow every year.

From a **species perspective**, the loss of habitats and refugia, both for predators and their prey, limit species and reduce opportunities for reproduction. As population sizes decrease, genetic variation declines as well, leading to the eventual removal of certain traits. According to the United Nations, 75% of plant genetic diversity has been lost during the last century.³² Reduced gene pools limit the adaptability of a species and its resilience to changing conditions. In the coming decades, at least one million species are at risk of extinction. Among the known species evaluated by the IUCN, amphibians are most affected with 40% threatened by extinction, compared to 25% of mammals and 15% of birds.

As a consequence of these intertwined developments, biodiversity loss entails considerable systemic risk. The World Economic Forum ranks biodiversity loss as the risk with the fourth-highest probability and third-highest impact.¹⁸ Systemic environmental collapse refers to disasters that take effect across local ecosystem borders, such as mass insect die-off, coral reef collapse, or the often-cited disappearance of the Amazon rainforest. The associated loss of ecosystem services can disrupt entire supply chains and industries, and render communities unlivable by triggering natural disasters, reducing the availability of food, medicines, and clean water, and disabling natural defenses against pandemics. In such a scenario, the economic loss of ecosystem services would be a multiple of current annual costs.

Assessing the Economic Benefits of Ecosystem Services

There is still much to learn about the monetary value of ecosystems, and current models are not perfect. However, by assessing the natural world in terms of economic benefit, we can quantify and relate these benefits to the fiscally driven world in which companies and governments operate.



On the one hand, knowing about the economic value of ecosystem services can help effect measurable change for ecosystems at risk. As our results indicate, mangroves are the ecosystems offering the largest overall economic benefit, with an estimated \$30 trillion delivered through the regulation of nitrogen and phosphorus waste, coastal protection, and carbon sequestration. But mangroves are being destroyed at an alarming rate. For example, in Indonesia, home to about one-fifth of global mangrove forests, aquaculture for extensive shrimp farming has been responsible for around 50% of mangrove deforestation. As a BCG study shows, farmers in Indonesia could earn more income by certifying carbon storage through intact mangrove forests than by continuing shrimp farming.⁹⁶ Therefore, understanding the economic benefits of ecosystem services can support the development of business cases for local protection and restoration.

On the other hand, any economic valuation of nature must be interpreted with caution. For example, although our findings indicate a relatively small monetary benefit from pollination (about \$0.3 trillion yearly), pollinators are essential for the functioning of almost all ecosystems and provide the basis for nature's ability to produce food and feed. Further, while oceans support a stable climate by absorbing large quantities of carbon dioxide from the air, this comes at a price. Dissolved CO₂ leads to ocean acidification, which damages shelled creatures, corals, and fish. Thus, all ecosystems and their functions, regardless of the estimated economic benefits, are an essential part of a stable and resilient natural environment—if we degrade or exceed the boundaries of certain ecosystem services, we risk losing more than the monetary value attached.

When assessing the economic value of ecosystem services, it is important to note that not all local ecosystems offer quantifiable services, and when they do, their values are rarely homogenous. For example, ice, rock, and desert ecosystems have not yet been thoroughly quantified in terms of their monetary benefits. The monetary value analyzed here should therefore be understood as a conservative estimate, covering only the lower end of nature's economic benefits. The ability of an ecosystem to continuously provide economic value depends on its intactness and thus its long-term management, protection, and cultivation.

Human activities

Major drivers of biodiversity loss

Loss of biodiversity and ecosystem services



Resource extraction



Land and sea use change (29%)

Habitat conversion and degradation, e.g., deforestation and overintensive use of (agro)ecosystems



Production



Direct overexploitation (26%)

Overexploitation of animal, plants, and ecosystems, e.g., from illegal trading, unsustainable logging, and overfishing



Service provision



Climate change (17%)

Future shifts in temperature and precipitation caused by increased levels of greenhouse gases in the atmosphere



Consumption



Spread of invasive species (12%)

Plants, animals, or other nonnative organisms entering or expanding into a given habitat

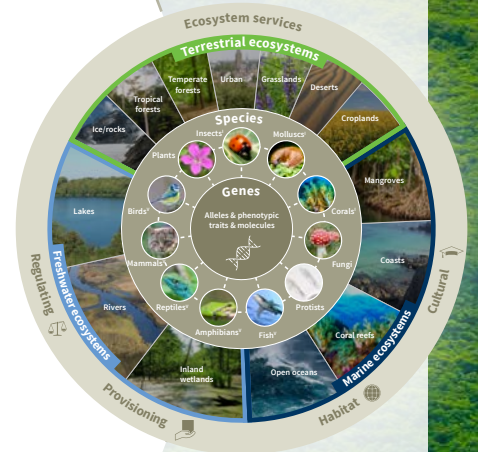


Figure 6: Drivers of biodiversity loss and underlying human activities. Source: BCG analysis based on IPBES (2019)

3. The Drivers behind Biodiversity Loss

Biodiversity loss can be attributed to five major drivers, as illustrated in figure 6: Land and sea use change; direct overexploitation; climate change; pollution of soil, water, and air; and the spread of invasive species. Human activities related to resource extraction, production, services, and consumption directly fuel these drivers and therefore biodiversity loss.

Biodiversity loss is closely linked to socioeconomic trends and a systemic problem society is facing: Most of our economic activities involve the exploitation of land, sea, and resources to sustain the consumption of a growing global population. Subsequently, the production and disposal of consumer goods generate pollution and waste. Modern societies have embraced objectives that aggravate these mechanisms, such as low prices for food, fashion, electronic devices, energy, or transport. The trade-offs between economic growth, societal well-being, and a prospering natural environment are further fueled by poverty and inequality as well as urbanization, globalization, and international trade. The consequence has been a downward spiral: As land is first converted for economic activities, further settlements follow. As land degrades from intensive cultivation, further ecosystems need to be converted. As new challenges like climate change arise, other pressures on biodiversity, such as the spread of invasive species, intensify. And as ecosystem services decline, more human intervention becomes necessary, such as the extensive use of chemicals on crop fields that have lost fertility and pest defense capabilities.

Overall, total human-caused pressure on biodiversity is split unequally among the five drivers. As shown in figure 6, changes in land and sea use and overexploitation together are responsible for 55% of pressure on biodiversity according to the estimates of IPBES.² However, climate change and pollution are becoming increasingly damaging. Especially continued global warming may have detrimental, hard-to-predict effects on biodiversity. Moreover, the five drivers of biodiversity loss are interdependent, and their intensity varies among ecosystems. For example, marine ecosystems are most affected by the overexploitation of fish and seafood stocks, while freshwater ecosystems are more exposed to drainage and pollution, such as from agricultural runoffs.

Land and Sea Use Change

Changes in the way land and sea are used are responsible for 29% of total human-caused pressure, including both the conversion and complete destruction of ecosystems and their habitats. Human-driven changes in land use result from agricultural expansion and intensification—for example, for food, feed, and biofuels; the expansion of urban and technical infrastructure; or the exploration of minerals, metals, and energy sources. Beyond ecosystem conversion, pressure on habitats may also result from their fragmentation; for example, as caused by new roads. At sea, most change is driven by coastal development and offshore aquaculture.

The loss of habitats gradually leads to a decline in biomass for those species that do not adapt. As biomass declines, the genetic variability within a species becomes more limited, reducing protection against disease and degrading its ability to survive in challenging conditions. As habitats fragment, reproductive opportunities decline, further limiting populations' size and variability.

Direct Overexploitation

The direct overexploitation of animals, plants, and ecosystems contributes 26% of total human pressures, referring to the extraction of more natural resources from the environment than can be naturally restored. Overexploitation leads to species extinction and the deprivation of indigenous peoples and local communities. Unregulated activities, such as overlogging or overgrazing, impact the ability of natural ecosystems to regenerate. Many oceans are currently overfished. Furthermore, illegal activities, such as wildlife poaching and the hunting or trading of exotic or endangered species, have resulted in the near extinction of iconic animals, including rhino, shark, and tiger species. Accordingly, overexploitation causes a direct decline in species biomass, with all the repercussions outlined above.

Climate Change

Climate change currently accounts for 17% of total pressure and will likely become more severe in the coming decades. In contrast to the other drivers, its effects on biodiversity can occur anywhere in the world independent of the origin of greenhouse gases, as they accumulate and disperse into the atmosphere. The resulting rise in average global temperature and changes in precipitation have far-reaching effects, altering the flora and fauna of many ecosystems and increasing the occurrence and intensity of extreme weather events. Climate change is a key accelerator behind biodiversity loss, destabilizing nature through ocean acidification, desertification, melting glacial landscapes, and catastrophic events like floods, wildfires, or droughts. An intensification of these factors can rapidly undermine the resilience of ecosystems, while warmer temperatures allow invasive species to gain a stronghold where native species may previously have outcompeted them. These effects are currently visible in many forest ecosystems in which dieback is magnified by the interaction of droughts, wildfires, and invasive species.

The ecological responses to these changes are multifaceted and can result in species becoming extinct, migration routes changing, the spatial distribution of species shifting, genes mutating, and previously isolated species interacting for the first time. According to IPBES, half of all threatened mammals and one-quarter of threatened birds have already been negatively affected by climate change.

Pollution

The pollution of soil, water, and air is responsible for an additional 16% of human-driven pressures on biodiversity. The main emitters of pollution are chemically intensive agriculture and aquaculture processes, oil or toxic waste spills during resource extraction, transportation, and industrial processes, including untreated waste and wastewater. Common pollutants include microplastics, heavy metals, endocrine disruptors, pesticides, fertilizing nutrients, and other chemicals from pharmaceuticals, cosmetics, or household cleaning products. As those substances enter soils, waterways, and the ocean, they adversely affect native organisms and change nutrient balances, acidity, and oxygen levels. For example, of the 20–25 million tons of phosphate annually used as fertilizer, around 8–10 million tons run off into inland waters, rivers, and oceans.³³ High levels of phosphates and nitrogen—mostly originating from agricultural fertilizers—cause eutrophication,³⁴ oxygen depletion, and aquatic death zones, as seen in the Baltic Sea in recent years.³⁵ Marine plastic pollution alone has increased tenfold in the past four decades, affecting over 800 marine and coastal species.²¹

Air pollution results from similar anthropogenic sources and involves gases such as nitrous oxide, fine particles, and organic pollutants. These substances add to the acidification and eutrophication of ecosystems, reduce the fertility and functionality of soils, harm plant growth, and cause the deaths of around 7 million people worldwide each year according to WHO.

Spread of Invasive Species

Invasive alien species are plants, animals, or other organisms that enter habitats other than their native ones. These alien species can be deliberately or unintentionally released through increased global movement, trade routes, cultivation, or tourism. The IPBES considers 20% of the Earth's land and water at risk from alien species infiltrating carefully balanced ecosystems and food webs.² Invasive species cause harm by competing for plants or prey, trampling soils, genetically hybridizing with native species, or transporting novel diseases.²¹ The damage caused by invasive species currently costs the European Union approximately €12 billion per year in agricultural losses, human health costs, and damage to infrastructure.³⁶ Moreover, 80% of threatened species are at risk of further decline due to predation by or competition with invasive alien species.³⁷ As mentioned above, repeated droughts and the destabilization of fragile ecosystems by climate change open new niches for alien species.

The Interrelations of Biodiversity and Climate Change



Climate change has been at the forefront of the environmental movement in recent years, and with good reason. But climate change and biodiversity are not mutually exclusive—both influence each other in dynamic feedback loops. Just like a stable climate, biodiversity is a crucial aspect of a resilient and functional planet, including the ability of healthy ecosystems to store carbon. As humanity battles to contain the amount of CO₂ in our atmosphere, it is vital that the systems able to sequester carbon don't themselves turn from sinks to sources. With a share of around 15% in global greenhouse gas emissions,⁴² deforestation and peatland drainage are among the major contributors to global warming. Part of this ecosystem conversion is linked to the cultivation of crops for biofuels, designated to reduce emissions from fossil fuel combustion. Biodiversity loss fosters climate change—and climate change, in turn, accelerates biodiversity loss. To address one, we must address the other.

As we look at climate change to develop approaches for addressing biodiversity loss, we must acknowledge that both mechanisms are also inherently different. Firstly, biodiversity exhibits more complex dynamics of cause and effect. Where climate change follows a pattern of physical and chemical process change, biodiversity requires an understanding of interrelated biological systems, that have nonlinear consequences at local, regional, and global levels. Secondly, the multidimensional characteristics of biodiversity make it more difficult to measure. Multiple indicators of the state of biodiversity, such as species abundance and the extent and functionality of ecosystems, need to be measured and linked to indicators of harmful activities—making it nearly impossible to derive an overarching metric, such as the CO₂ equivalent for climate. Finally, biodiversity loss requires a regionally differentiated approach because of its local nature. No two protection and restoration efforts are the same, making the global target setting, alignment, and best practice sharing inherently complex. Emission reduction, meanwhile, can be achieved through globally similar approaches. These three aspects make addressing biodiversity loss even more difficult than combating climate change but certainly no less urgent.

Drivers of biodiversity loss

Share of pressure on biodiversity per economic activity

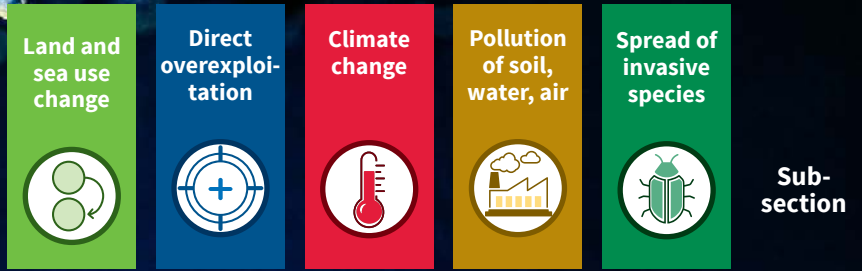




Figure 7: Economic activities, share of pressure on biodiversity.
 Note: The size and color of flames indicate each activity's contribution to the five drivers of biodiversity loss; activities with very small share and illegal activities are disregarded.
 Source: Analysis by BCG and NABU (details in appendix)

 Size: Relative contribution to drivers of biodiversity loss
 Gray: Lower, but not negligible contribution

4. The Critical Role of Economic Activities

Economic activities along all stages of the value chains of products and services contribute to the five drivers of biodiversity loss: From resource extraction and conversion of raw materials to product manufacturing, services, and consumption, each stage involves both a direct impact on ecosystems, species and genetic diversity, and systemic environmental effects from emissions. Figure 7 shows the distribution of total pressure on biodiversity from all types of economic activities and indicates through which of the five drivers of biodiversity loss the impact arises (see appendix for our methodology).

As indicated by the size of the colored flames in figure 7, the five drivers of biodiversity loss are fueled by different economic activities in different intensities but with similar patterns: Land and sea use change most commonly results from the expansion of agricultural lands and plantations, and the setup of resource extraction sites and other infrastructure. Overexploitation of ecosystems and local species is especially caused by fishing, forestry, and mining activities. Climate change, pollution, and the spread of invasive species, however, are fueled by activities all along the economic value chain.

While consumer waste, responsible for an estimated 6% of the pressure, has been highly present in the recent public debates, the results of our analysis show that the lion's share of pressure on biodiversity needs to be tackled further upstream of the economic value chain—where large shares of the dominant drivers land and sea use change and overexploitation are caused. Overall, almost 80% of the pressure on biodiversity comes from primary and secondary sector activities. Among those, we selected five cases with particular complexity and relevance for worldwide supply chains and economic development: farming, forestry, mining, industrial production, and infrastructure expansion. Companies involved with these activities play an important role in overcoming the global biodiversity crisis and need to be enabled to avoid further biodiversity loss.

Although farming, forestry, mining, industrial production, and infrastructure expansion are driven by very different sectors, the analysis we present in the following chapters shows clear similarities in what is needed to reduce their biodiversity footprint: Essentially, biodiversity needs to be integrated with companies' decision-making and operational processes. Business executives should develop strategies to create transparency on their firm's biodiversity footprint, reduce the necessity for land conversion,

implement processes with lower water and raw material use, reduce emissions, and avoid pollution – details are provided in the following.

However, companies cannot change the system on their own. They need supportive measures and incentives from different stakeholders. Therefore, after assessing the root causes of pressure for each economic activity and developing sector-specific recommendations for business, an in-depth analysis of societal levers for action is proposed in chapter 5.



A. Farming

Farming is crucial to meeting society's needs for nutrition and clothing and employs around one billion people globally. However, farmers around the world face many social, economic, and environmental challenges, including the lack of access to knowledge and technology, financial pressure due to low food prices, and more frequent extreme weather events. According to scientists, up to 30-40% of global harvests are lost to pest (including resistant weeds) each year.³⁸ At the same time, agricultural activities contribute substantially to environmental challenges such as climate change and soil degradation, and are responsible for more than 60% of species decline.³⁹ Growing global food and resource demand have increasingly led to large-scale transformation of natural ecosystems to farmlands and croplands, farming's primary impact on biodiversity. Many farmers also responded to the pressures by adopting intensive cultivation practices for maximum yield and efficiency. For example, the use of chemical plant protection products has doubled since 1970.³⁹ Alternative, more biodiversity-friendly systems are increasingly being demanded, explored and incentivized, but are still largely underrepresented.³⁹ Effectively, by contributing to the global loss of biodiversity, farming interferes with the very premises it rests upon – the focus box below expands on the consequences for ecosystem services. Since farming covers the major share of the terrestrial area and will continue to provide the basis for our well-being, farmers and landowners need to adopt solutions that integrate crop production, animal husbandry, and biodiversity.

Root Causes of Pressure

Our analysis shows that farming systems are responsible for around 26% of the pressure on biodiversity. Above all, the **conversion of land for agricultural expansion** is the largest driver of biodiversity and ecosystem decline. The development of farmlands and croplands is causal to 80% of global deforestation² and, together with unsustainable cultivation systems, has contributed to putting approximately 40% of global insect species near extinction.⁶ The conversion of biodiversity-rich ecosystems often involves significant losses of associated ecosystem services, such as carbon sequestration or water regulation. The pressure on unspoiled ecosystems is further enhanced by the utilization of fertile lands for biofuels, animal feedstuffs, and unsustainable plantations (such as for palm oil) instead of food crops.

Beyond that, farmlands, especially in industrial nations, often involve large **homogenously cultivated areas** with few field margins or other structural elements. Homogenous landscapes do not provide sufficient space for wild species (such as insects, plants, and fungi) to feed, migrate, and reproduce, resulting in the decline of ecosystem services, such as natural pest control or pollination. The lack of biodiversity in the cultivation of crops itself exacerbates this trend – globally, only nine crops are responsible for 66% of global food production – increasing the vulnerability of surrounding ecosystems to environmental changes.⁴⁰ Furthermore, **intensive cultivation practices** like narrow crop rotation, land preparation with heavy machinery, and large-scale surface irrigation put enormous pressure on soils, hurting soil organisms and causing erosion. More than 30% of soils worldwide are now considered degraded,⁴¹ having lost most of their humus layer and water-saving capacity. The accompanying rapid exhaustion of soil fertility and productivity again intensifies the pressure on the remaining natural ecosystems.

Conventional farming often relies on the extensive **application of synthetic fertilizers and plant protection products**, both of which may pollute the surrounding environment. Chemical fertilizers can cause significant damage to soil organisms and may moreover enter waterways through leaching or runoff, leading to eutrophication and dead zones. Moreover, nitrogen oxide emissions from fertilized

soils pollute surrounding areas, which can inhibit the growth of forests due to soil acidification. Extensive use of chemical crop protection products has been linked to declining insect populations and can be toxic for all kinds of organisms (such as amphibians, reptilians, or fish). Additionally, it often triggers resilience in pests, making cultivation more challenging.

Finally, farming contributes to over 20% of global **greenhouse gas emissions**, half of which come from carbon release during deforestation for agricultural expansion.⁴² In addition, significant amounts of carbon dioxide are emitted by drained peatlands. Cultivated soils emit nitrous oxide, and livestock farming additionally causes methane emissions from animal breeding and nitrous oxide emissions from manure.

Sector-Specific Recommendations

To attenuate negative influences on biodiversity, as outlined in the BCG report *Sustainably securing the future of agriculture*⁴³, farmers and agribusinesses especially need to reduce the conversion of natural habitats and further implement biodiversity-friendly cultivation practices on agricultural lands. Important measures include wider field margins, a greater variety of locally sourced crops and seeds, mixed cropping, and intercropping with soil-replenishing legumes.⁴⁴ These practices support local wildlife, improve soil quality and pest control, and thereby help farmers to reduce the use of synthetic fertilizers and plant protection products. If chemical pest control is not avoidable, integrated, biodiversity-smart solutions should be adopted to ensure that only less-toxic substances find their way to the field. Agricultural suppliers have started adjusting their portfolios to these needs, and emerging solutions like the predictive and precise application of fertilizers and crop protection products could facilitate biodiversity-safe cultivation if customized to smaller scales. For tackling the pressure on climate change, peatlands should be rewetted wherever possible. Finally, in selected regions, land-based livestock farming can help to reduce water and soil pollution as well as emissions.⁴⁵ The *EU Biodiversity and Farm to Fork Strategies*¹³ provide a framework for farmers and agribusinesses to act: They aim to establish nonproductive landscape elements on 10% of arable land, increase organic farming to 25%, and reduce synthetic pesticide and fertilizer use by more than 50% by 2030. This fits the current trend in the sector, with many farmers and agribusinesses starting to break new grounds and adopt alternative systems like organic farming or regenerative agriculture.

Overall, the biodiversity impact of farming is closely linked to the major trade-off in today's food systems: focus on achieving maximum yields on a smaller land area using intensive cultivation practices, or focus on biodiversity-friendly cultivation with potentially lower yields and consequently higher land use. This conflict can only be mitigated by changing both consumption and production patterns. As the *EAT Lancet Commission* shows, a more sustainable food system requires dietary shifts towards more plant-based diets and the reduction of food loss and waste alongside efficient and biodiversity-safe cultivation practices.⁴⁶

Consequences of Ecosystem Service Decline: Farming

The depletion of nature's services can cause severe risks in terms of economic value and human livelihood. In the example of farming, large declines in provisioning and regulating functions have been the result, including annual losses of up to 2% in the formation of fertile soils, pollination, or disturbance moderation. The loss of services like soil fertility and pollination may put the value creation of entire sectors, such as food and textiles, at risk. For essential ecosystem services like erosion prevention and climate regulation, the relative decline even translates to economic losses of more than \$100 billion per year (see details in appendix). These losses are not static but add up; for example, the over 5% of EU soils suffering from severe erosion lose a further 0.5% of productivity each year.¹⁰¹





B. Forestry

Similar to farming, the impact of forestry on biodiversity is subject to patterns in consumer demand and local economic needs, which both impact forestry management practices. The demand for wood-based products is increasing on a global scale, with markets relying on paper, wood products, and wood-based fuel.⁴⁷ With the expected economic shifts to sustainable packaging and green construction, and away from fossil-fueled energy generation, this demand looks set to increase. Harvesting activity mirrors these trends with its 45% increase since 1970.³⁹ The resulting impact on biodiversity depends on the type of local forest management, forest biome and state, and local regulatory standards. Today, up to 40% of the world's managed forests are considered sustainably managed, and around 30% are certified, thereby already reflecting the ambition to improve practices and protect local biodiversity.⁴⁸ However, especially illegal logging is responsible for a major share of deforestation and careless, biodiversity-damaging harvesting. In many countries, logging and land conversion for farming go hand in hand as they provide a livelihood to local citizens and serve political interests; for example, the election of President Bolsonaro has seen deforestation in Brazil surge by 80% since 2018.⁴⁹ On a global scale, forest area has decreased by 129 million hectares between 1990 and 2015.⁴⁸

Root Causes of Pressure

Forestry contributes to an estimated 11% of the pressure on biodiversity, especially due to **deforestation** in close-to-nature forests. Deforestation is often the final result of reinforcing loops of wood extraction; for example, a steady extraction of fine tropical woods may attract the establishment of plantations in the cleared areas, which again attract urban settlements. Certain land clearance techniques, such as the slash-and-burn method,⁵⁰ furthermore increase the risk of fires with far-reaching effects for bordering ecosystems. However, forestry itself makes up just a small part of the reason behind deforestation, which is mainly driven by the global demand for certain agricultural goods like soy or palm oil. Overall, deforestation is responsible for about 50% of forest loss annually,²⁸ most often affecting primary and regenerating forests with high biodiversity and little prospects of like-for-like restoration. Alarming, more than 80% of future deforestation is expected in nature's most delicate landscapes.⁵¹

Biodiversity loss can also result from **inadequate forest management**, occurring when local ecosystem needs are not sufficiently reflected in management practices. First, conventional logging techniques may **overexploit** local ecosystems by harming soil structures, straining species, and fragmenting habitats, all of which lead to the loss of refugia and ecological corridors. Second, not least due to the degradation of disturbed forest floors, forest cultivation is linked to around 2% of global **greenhouse gas emissions**.⁵² While afforestation may serve to offset emissions, the carbon sink potential of planted forest varies, and the seeding process may release further CO₂. Third, inadequate afforestation with non-native species or insufficient structural planning in monocultures may even attract invasive species and cause further **degradation**; for example, when water balances are disturbed, as it often results from the establishment of eucalyptus plantations.⁵³

Sector-Specific Recommendations

To minimize ecosystem damage, all forestry companies should ensure proper assessments of environmental and specifically biodiversity impact. Where cultivation is acceptable, companies should build on established forest management practices and tailor them to local needs. Above all, this includes making provisions to maintain local forest resilience and preserve ecosystem functions for the future. Long-term, silviculture-based management involves creating buffer zones for wildlife, maintaining key vegetation and leaving areas to natural regeneration. Forest health and biodiversity development should be continuously tracked. Finally, harvesting procedures should be centered around forest wildlife to avoid disturbances. This involves using existing forest roads for transport to minimize soil damage and adjusting working hours to local species' routines.



C. Mining and Extractive

Extractive activities are a globally important source of economic prosperity, making up over 60% of GDP in 81 countries.² The major forms of nonrenewable resource production are coal mining, metals mining, quarrying, and oil and gas exploration. Each year, almost 70 billion tons of fossile raw materials are extracted, more than triple the amount of 1970.⁵⁴ As some sectors like coal and oil are set to decline, others take their place, driven by technological change. Copper demand, for example, is expected to double, or even triple over the next 20 years based on its role in renewable energy generation.⁵⁵ Beyond around 17,000 large-scale mining sites, the recent IPBES report additionally highlights the existence of smaller, sometimes illegal pits.² Those may pose a particular threat to biodiversity, as they are often located in delicate, well-vegetated areas, such as the Congo basin or the Amazon rainforest. As deposits are depleted in easily accessible areas, mining activities increasingly move into such sensitive zones. While many firms and governments are promoting nature-sparing ways of raw material extraction, others are neglecting its environmental impact – as exemplified by the recent repeals of conservation laws in the USA.⁵⁶ Despite such prominent anecdotes, the general public’s awareness of products’ raw-material footprints is still limited, indicating a need to elucidate the biodiversity risks of resource extraction.

Root Causes of Pressure

In contrast to farming and forestry, extractive activities may exert less extensive, yet locally even more severe pressure on biodiversity. Already during the exploration and setup phases, mine and rig operators need to manage the risk of **habitat conversion and fragmentation**, as the land cover is removed for quarries, underground tunnels are excavated, or deep-sea ecosystems are disturbed by drilling. Insufficient care during operations and decommissioning, meanwhile, may cause persistent damage to local ecosystems, as seen in the 2019 Brumadinho dam accident in Brazil,⁵⁷ or in India’s underground coal mine fires.

Regular mining and drilling operations involve three more potential sources of pressure. First, continued extraction, processing, and transport may result in **ecosystem degradation** if wildlife is disturbed, soils erode, and waterways become sedimented. Moreover, heavy water extraction, such as for ore processing, can gradually dry up surrounding forests or wetlands. A third of global forests are said to be affected by large-scale mining sites.⁵⁸ In response, some industry front-runners have already introduced circular water management systems. Second, many extractive processes involve a high risk of **soil and water pollution**, thus requiring strict operating standards. Contaminants may be carried into soils and waterways through runoff from tailings or waste compounds, or by the direct discharge of untreated wastewater or brine. Some particularly toxic fluids, including cyanide spilled during gold leaching or the flowbacks from natural gas fracking, may severely harm local organisms and impair ecosystem functionality. Third, mining requires the management of **greenhouses gases and air pollution**. Some operating emissions like dust from quarries, methane leaked during fracking, or heavy metals from the leaching of rare earths can both affect local ecosystems and cause further-reaching toxic smog and acid rain. In addition, the heavy machinery used in processing and transport often releases significant CO₂, which has induced first mining companies to fully switch to renewable feedstocks.

Sector-Specific Recommendations

Environmental pressure on operators has increased in recent years, driven by industry initiatives such as *Responsible Steel* but also by investor demands.²⁰ In response, major raw material providers have started adopting environmentally safe operating models. Above all, this involves avoiding the exploration of biodiversity-rich areas, in particular designated protected areas. This should be facilitated by strengthening recycling and circular approaches in the use of resources. On those sites being explored, thorough impact assessments are required to guide subsequent provisions to reduce biodiversity impact. First, companies should invest in long-lasting infrastructure and optimize nature-sparing techniques, such as high-precision metal extraction. Second, any risk of pollutant leakage should be minimized; for example, through wastewater treatment, desalination, or methane capture. Third, many options exist to reduce carbon emissions, such as shifting to minerals that require less energy-intensive extraction, utilizing electric mining vehicles, and optimizing transportation routes. Finally, miners may support ecosystem rehabilitation after closure; for example, by habitat creation in former operating sites. Naturally, all measures should be supported by continuous monitoring of their impact on biodiversity and surrounding ecosystems.



The Biodiversity Impact of Luxury Goods

Many consumer products have a biodiversity footprint that is invisible to purchasers and may surprise them by its magnitude. A striking example is the lack of common awareness on the origin of luxury goods, such as premium watches. Gold and other precious components of these popular accessories often come from sites of high biodiversity risk, including a plethora of gold mines in protected areas like the Amazon rainforest. Frequently, these sites are not sufficiently regulated and discharge high levels of pollution, including contaminants like mercury and cyanide, which can have devastating effects on local plants and wildlife. Furthermore, some of these mines are involved in the annual deforestation of thousands of hectares of indigenous rainforest reserves.⁹⁷ This case exemplifies that in long and opaque supply chains, change can only be brought about by mindful stakeholders. Producers, consumers, and investors should demand complete transparency of the entire value chain of luxury goods to ensure they are not contributing to the destruction of one of the most precious ecosystems on earth.



D. Industrial Production

Industrial production is at the heart of many essential value chains that transform raw natural resources, like metals or oil and gas, and organics, like crops and wood, into end products such as cars, consumer technology, pharmaceuticals, chemicals, processed food, or clothing. Global demand for products from heavy industry, like chemicals and most metal derivatives, has been rising in recent decades,⁴⁷ driven by consumption patterns and ongoing industrialization in many countries. While each new plant requires land conversion, we focus on the larger emission and waste impacts, which are also increasingly at the center of many industrial firms' sustainability initiatives. In recent decades, both the use of electricity and water and the generation of waste and CO₂ per dollar of revenue have been growing steadily. Depending on the enforcement of environmental standards, these production in- and outputs may entail a significant impact on biodiversity.

Root Causes of Pressure

While the biodiversity impact from industrial production differs locally and by sector, there are some similarities between the sources of pressure in the industrial value chain. The majority of emissions and waste arise during the conversion of raw materials, often occurring close to extraction sites and in large process industries. First, in many plants, such as oil and gas refineries, petrochemical plants, steel factories, or pulp and paper mills, **soil and water pollution** are a high risk. Wastewater and sludge from production often contain heavy metals, toxic solvents, nutrients, and organic matter. As those chemicals leak and accumulate in neighboring ecosystems and food chains, they may intoxicate animals, inhibit plant growth, or attract invasive species; for example, through the eutrophication of waterways. Solid waste runoff can settle in waterways, blocking watersheds and changing natural courses. Finally, heavy water extraction, for example, for cooling in metallurgical processes, can deprive ecosystems of clean water if not properly compensated.

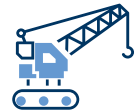
Second, industrial plants represent a major source of **air pollution and greenhouse gas emissions**. On the one hand, unfiltered particles, toxic gases, and organic pollutants can cause smog, acid rain, and ozone depletion. On the other, almost 20% of global CO₂ emissions are created through industrial heat and processing, not including indirect emissions from power use.⁵⁹ Around half of these emissions come from metallurgy and mineral processing, including cement production, and another approximately 25% from chemicals production. Additionally, some processes like fertilizer and fiber production involve significant nitrous oxide emissions.

Sector-Specific Recommendations

While in many countries environmentally friendly production practices are under development, the standards in other areas are still too low, not specific to biodiversity, or not adhered to. Biodiversity-safe industrial production requires using primary inputs and conversion techniques with a small footprint, treating pollution sources, reducing the risk of accidents, and adopting strict waste management

procedures. Companies may even assume stewardship roles for the protection of local ecosystems and join forces with NGOs to ensure compliance with biodiversity needs. The ongoing automation, digitization, and green technology development moreover provide chances to reduce emissions and waste from operations. Biodiversity-safe production is in fact highly connected to the concept of a circular economy – innovations are needed that allow firms to increase process efficiency, reduce product resource intensity, and promote circularity by recovering and recycling both byproducts and parts of final products. In terms of greenhouse gas emissions, hard-to-abate industries should further explore the suitability of carbon capture and storage or utilization, which may soon provide a positive business case in sectors like petrochemicals.⁶⁰

E. Infrastructure Expansion



In contrast to the other high-pressure activities, infrastructural expansion is less market-driven but even more tied to demographic trends. By 2030, the global population is expected to include five billion urban dwellers.⁶¹ As a consequence of this growth, the UN Food and Agriculture Organization expects an additional 100 million hectares of land to be required by 2050 for housing, industries, transport networks, and other infrastructures, such as power plants, transmission lines, dams, tunnels, and bridges.⁶² Most of this new infrastructure will be located in or operated by developing and emerging nations. A prominent example is the *Belt and Road Initiative*, a new silk road project orchestrated by the Chinese government, which heavily invests in roads, railways, and maritime routes to enable international trade.

Root Causes of Pressure

While infrastructure is crucial for economic development and community empowerment, it may bring major harm to biodiversity if projects interfere with local ecosystems and do not provide for adequate relocation or restoration. First, infrastructure erection involves **full land sealing**, which naturally results in the conversion of local habitats but can also extend into surrounding ecosystems; for example, from modifications to waterways. Economic infrastructure also attracts further settlement, which may accelerate biodiversity loss. Second, the **fragmentation of habitats** caused by lengthy infrastructural elements, such as roads and railways, may impede species access to migration routes, feed, and mating grounds, and thereby also limit gene flows. Third, **pollution and waste** from construction sites include solid waste runoff as well as noise, light, and air pollution created during infrastructure construction, which often translates to significant stress for local populations. A major share of global solid waste effectively results from construction – in the US this number comes to 50% – and is often stored in large compounds adjacent to local ecosystems.⁶³

Sector-Specific Recommendations

Although it may be tempting to focus on the visibly destructive construction phase of an infrastructure project, manifold decisions that affect the actual damage to local habitats are already made during the design and engineering stages. To minimize biodiversity impact, project owners should follow the mitigation hierarchy.⁶⁴ This first requires critical reflection on whether the new infrastructure is absolutely necessary, or if there are ways to meet the aspired purpose while not building (“zero option”). In the former case, intrusion into delicate habitats should be avoided by embedding environmental compatibility criteria into planning and ensuring thorough impact assessments. Siting decisions should be forward-looking, in anticipation of future needs for expansion. In addition, contractors should develop designs that enable resilience and longevity and establish preventative maintenance to avoid unnecessary extra construction work. Next, “design to nature” principles can help to create infrastructures that match the needs of the surrounding biodiversity, based on a comprehensive analysis of local ecosystem structures. For example, the spatial structure of projects can be adjusted to natural structures, such as waterways, and infrastructure can be designed to maintain animal refuges and ecological corridors, such that wildlife can avoid human interaction. Moreover, integrating existing green infrastructure can help to preserve valuable ecosystem services.⁶⁵ Finally, habitat relocation and restoration are a last resort and should be local. During the construction process itself, disruptions can be minimized through low-noise and -emission machinery and by adapting works to local species’ lifestyles. Further advice and frameworks can be gathered, for instance, from the *EU Framework for Biodiversity Proofing*.⁶⁶



5. Systemic Change Is Required

The evidence is now clear: We need to reverse the trend of biodiversity loss and develop solutions to maintain a stable and resilient planet. Since we are facing a systemic challenge, systemic change is needed. As we have shown in chapter 4, selectively addressing certain sectors and protecting biodiversity hotspots is a first step, but will not be sufficient. A new economic paradigm is required in which all actors – companies, consumers, governments, and finance – adopt environmental preservation as a key to success. We need to move from the destruction of biodiversity towards a system where economy and nature “cross-fertilize” each other to the benefit of society. The following chapters elaborate on what biodiversity really needs, which six major levers can effectively serve to protect and restore biodiversity, and how each stakeholder can take action.

5.1 What Biodiversity Really Needs

To reflect biodiversity in economic decisions and develop effective preservation approaches, all stakeholders need a good understanding of its components and requirements. Yet knowledge of biodiversity’s needs and the regional applicability of established conservation approaches is too fragmented. Our analysis in chapters 1 to 3 shows that biodiversity reaches beyond addressing the extinction of species: A variety of intact ecosystems with diverse species, genetic variation, and connecting elements are required to maintain nature’s services. Fundamentally, future biodiversity action should strive to ensure that all native ecosystem types and successional stages are represented across their natural range of variation, that genetic diversity and populations of native species are maintained, that ecological functions are preserved and ecosystem services enhanced, that diverse ecosystems are restored to maximize carbon sequestration, and that nature can adapt to the impacts of climate change.⁶⁷

» Beyond protected areas, we need integrated land use management to preserve biodiversity.

Jörg-Andreas Krüger, President, Naturschutzbund Deutschland (NABU)

To ensure the resilience and functionality of ecosystems, solutions need to take on a landscape perspective. Habitat structures, biotopes, species, and interdependencies with adjacent ecosystems determine the feasibility of proposed land use—and whether a local intervention can be compensated through relocation or restoration. The most relevant premises for successful preservation of biodiversity are shown in figure 8 and should be considered when implementing any of the following levers.

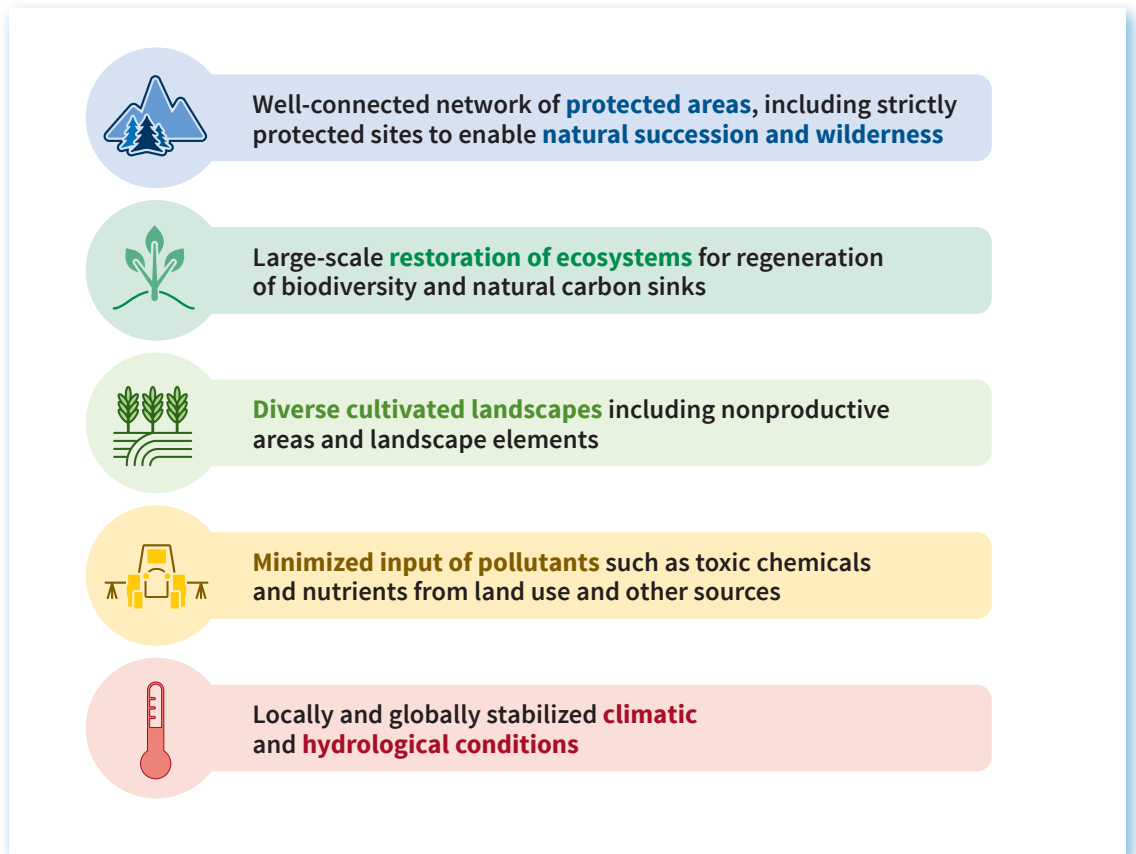


Figure 8: A landscape perspective: Premises for biodiversity protection and restoration. Source: BCG; NABU

5.2 Six Major Levers for Biodiversity Action

In consideration of the specific needs of biodiversity, we have clustered six major levers for biodiversity action, as shown in figure 9. This overview should guide stakeholders to develop thorough biodiversity strategies, set targets, and deliver on those. While most instruments can be implemented by several different societal stakeholders, some require action from specific interest groups (see chapter 5.3 on opportunities to act per stakeholder group).

Global preservation efforts should involve action on each of the six levers, compliance with existing legal standards and procedures provided. The first lever, namely protection, restoration, and integrated land use, is the most important to halting the biodiversity crisis and can be supported by almost all stakeholders. Nonetheless, all other levers are needed for the transition towards a biodiversity-safe future. Generally, some measures can be broadly utilized right away, while others require greater rollout efforts due to the complexity, costs, and interests involved.

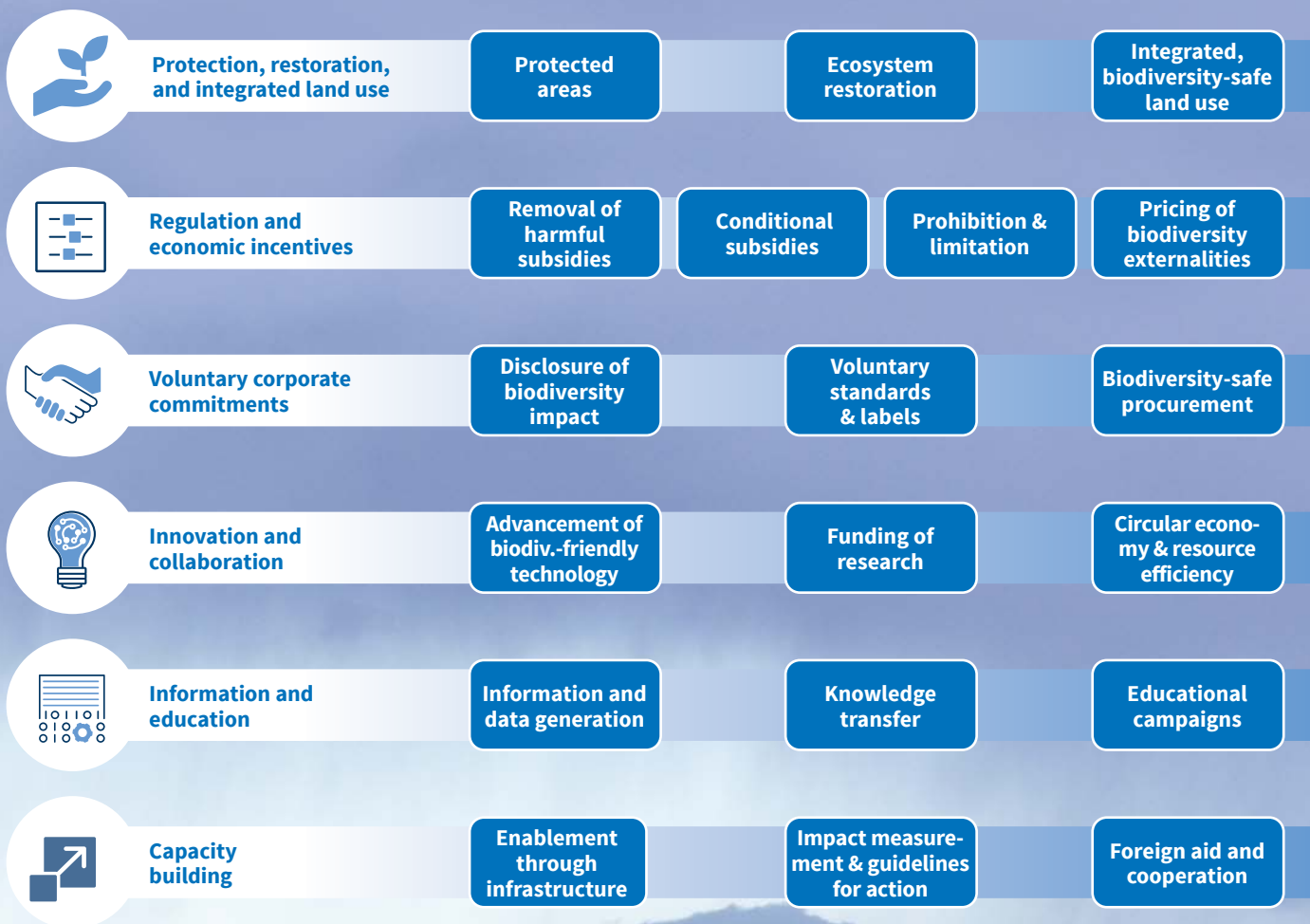


Figure 9: Levers and measures for biodiversity action.
Source: BCG; NABU

5.2.1 Protection, Restoration, and Integrated Land Use

The primary needs of biodiversity, as mentioned above, are best served by shielding healthy ecosystems from human intervention, restoring disturbed ones, and integrating biodiversity-friendly land use models. Accordingly, legislators must extend protected area networks and ensure their effective monitoring, management, and protection. Effective spatial planning can facilitate protection and reduce the need for restoration by directing urban settlements towards low-risk areas.⁶⁸

Protected areas are particularly crucial to biodiversity-rich and threatened areas to control human impact and allow ecosystems to evolve naturally.⁶⁹ The European Commission proposes to extend protection to 30% of land and sea areas.¹³ The designation and accessibility of these areas should be adapted to their distinctiveness and level of threat as well as their systemic relevance as part of the global biodiversity web. Since many species cannot thrive in isolation, the coherence and connectivity of protected

areas are crucial for wildlife migration, dispersal, and genetic exchange. To enforce protection and preservation of biodiversity-rich and threatened areas, national and local authorities should strengthen conservation laws, prevent illegal logging and mining activities, and award concessions only for low-risk areas. For each site, they should demand locally adapted environmental plans and continuous reporting on the health of soils and surrounding waterways. NGOs and environmental agencies can support protection through impact assessments that accurately represent local needs. Likewise, certification providers should further adapt standards to the distinctiveness of regional ecosystems. Beyond the rigorous enforcement of protection statuses, the management of these protected areas deserves close attention and ambitious investment. Involving indigenous people in protection can support enforcement and ensure that their needs are respected; successful examples for stewardship are provided by the recent *UNEP Global Environmental Outlook*.²¹ Overall, the benefits of investment in protected areas significantly outweigh the costs. Still, the world needs to ramp up its investment in protected areas, which currently is just over \$24 billion per year.⁷⁰ A recent report by the *Campaign for Nature* found that effective protection of 30% of the planet's area requires a sixfold increase in global investment.

Restoration is needed to stabilize and regain the lost functions of converted or degraded ecosystems. The Leopoldina academy estimates that the 1.5° C target for global warming requires the restoration of at least 100 million hectares of land.³⁹ Restoration efforts should focus on ecosystems with high potential for both biodiversity and carbon sequestration, to support the mitigation of climate change. Examples include natural wetlands, peatlands, seagrass beds, mangroves, and tropical forests. The UN recently initiated the *Decade on Ecosystem Restoration*, aimed at restoring 350 million hectares by 2030.⁷¹ The European Union is preparing legislation on restoration for member states. Meanwhile, NGOs and local authorities are running pilot schemes to involve corporates, such as in the restoration of Indonesian forests.⁷² Business models can be created from the – prudent – harvest and commercialization of natural products, but also by assigning credits for the recovery of ecosystem functions. Most platforms focus on carbon sequestration, like the *UN REDD+* platform,⁷³ but their mechanics could be extended to other measurable ecosystem services and biodiversity. Importantly, restoration projects need to consider local ecosystem structures and species' needs, involve indigenous populations, and ensure continuous tracking of restoration success.

Finally, **integrated land use models** promote cultivation and extraction in conformance with local ecosystem needs. Those models can be promoted by providing strong regulatory frameworks and incorporating financial benefits for the landowners and users who decide to deliver such public services to society. As analyzed in chapter 4, economic sectors, such as farming, forestry, and mining, play an important role for transitioning to biodiversity-friendly practices and integrated land use models. A common example is integrated forest cultivation following silviculture guidelines. Importantly, biodiversity-friendly land use should involve social and economic benefits for private landowners, local communities, and indigenous peoples, beyond the motivation to preserve nature. Public authorities and NGOs should promote the extension of the integrated land use concept to farming; for example, by means of the EU's *Common Agricultural Policy*, fisheries, and land use policies. The *EU Biodiversity Strategy* recommends 10% of agricultural land to be managed specifically for biodiversity. In mining, concessions could be developed to support the renaturation of sites between extraction periods. A current example is the initiative of the German Federal Mineral Resources Association (MIRO) and *Naturschutzbund Deutschland*, which is now developing concepts for integrated nature conservation in mining sites.⁷⁴

Companies should consider integrated land use models on their own land—but can also voluntarily engage in **corporate land stewardship programs** for the protection of local ecosystems and the remediation of prior damage, as shown in the respective focus box. Thus, companies draw benefits from the mitigation of risks and the certification of their products and services as biodiversity-friendly. Additionally, business models could be based on ecosystem service preservation—even on other firm-owned lands or private territories. For example, in the State of New York, farmers were compensated for maintaining the water treatment capacity of local forests.²¹

Nature-Based Solutions for Biodiversity and Climate Change



Core mechanism

Nature-based solutions (NBS) combine biodiversity preservation and climate change mitigation and adaptation through the restoration, protection of intact ecosystems, and restoration of degraded ecosystems.

Potential for biodiversity: What can be achieved?

- NBSs aim to achieve the restoration of ecosystem health and functionality, including many regulating services, such as carbon sequestration potential.
- Many prominent targets focus on reforestation and afforestation. For example, the *New York Declaration on Forests* wants to reforest 350 million hectares by 2030, and the EU Green Deal aims at 3 billion new trees in the EU by 2030. Since forests regain their full health mostly through natural succession, afforestation is not very effective, and seeding often releases CO₂.⁵⁸ Yet, restoring the original tree cover with native tree species can recover most ecosystem services formally provided by forests.⁹⁸
- However, peatland restoration provides even greater potential, because peatlands contain twice the amount of carbon of forests.⁹⁹ Their net sink function can be reinstated through rewetting and support by peat-forming vegetation.
- Other ecosystems with significant potential for biodiversity and climate change are mangrove forests, species-rich grasslands, floodplains, and seagrass beds in the oceans.

Safeguards: What needs to be considered?

- NBSs should not be considered as a substitute for a rapid fossil fuel phaseout and decarbonization of industry, neither for preserving still existing biodiversity areas.
- Each restoration project should cater to the following: Biodiversity objectives must be of equal importance as climate objectives; native vegetation, ecosystem health, and resilience should be restored; social aspects, such as the interests of local communities should be considered; and coherence and connectivity of protected areas ensured.

5.2.2 Regulation and Economic Incentives

Regulation is required to guide stakeholders in avoiding a negative biodiversity impact and to constrain harmful practices and inputs. Provided regulatory instruments are established and enforced at the appropriate level, they can ensure a level playing field in the market, for producers, traders, and consumers. Locally adapted standards, inspired by higher-level targets and regulation and the latest state of scientific knowledge, are essential to minimizing damage from ecosystem interventions. As regulation and guidance take time and will always lack certain detail needed for the local situation, companies are advised to develop their own biodiversity strategy and practices to avoid competitive and reputational disadvantages and legal uncertainty.

Crucially, economic incentives are needed to motivate all stakeholders to act in a biodiversity-friendly way. Regulators, along with NGOs and customers, must ensure that companies involved with biodiversity integrate their footprint into economic decision-making. Foremost, regulators should **remove and reform harmful or biodiversity-adverse subsidies and incentives**, such as the US tax breaks for shale oil and gas,⁷⁵ or the frequently discussed first pillar of the EU's *Common Agricultural Policy*, which still incentivizes large-scale intensive farming through per area payments. **Targeted, conditional subsidies**, although costly at fiscal levels, allow incentives to be combined with economic support for those stakeholders that engage in biodiversity-friendly operations. Public support should be tied to the delivery of public goods like carbon sequestration and specific conservation services. Thereby, subsidies can

enhance the financial attractiveness of biodiversity-friendly systems by creating local, predictable impact without direct consumer charges.

Regulators must also establish biodiversity-conforming standards. First, they can **prohibit harmful practices** and inputs, such as the most toxic pesticides, wildlife trade, or highly damaging resource extraction methods. Regulators can prohibit imports linked to biodiversity destruction and deforestation, as pursued by the *EU FLEGT Action Plan*.⁷⁶ Prohibition can also be applied through spatial zoning (protected areas) or within value chains, shifting demand to producers with low biodiversity impact. For example, the EU is currently discussing a framework for deforestation-free supply chains.⁷⁷ Moreover, banning environmental dumping throughout the market (including trade standards) could significantly improve the economic attractiveness of biodiversity-friendly production and consumption. Finally, significant **changes in bilateral and multilateral trade agreements** are needed, which must include strong biodiversity safeguards. Otherwise local efforts of firms and stakeholders might be undermined by economic pressures.

The amount of harmful substances entering ecosystems can be steered by **capping the use of inputs or setting output limits**. Examples include the EU Nitrates Directive for the protection of waters against pollution from agricultural fertilizers,⁷⁸ or the *EU Emission Trading Scheme*, which controls the aggregate amount of carbon emissions and provides incentives to reduce them on a single-firm basis. Furthermore, if biodiversity impact is deemed unavoidable, regulation can facilitate its compensation through **offsetting**, or companies can choose to voluntarily offset unavoidable impact (see focus box below). Although biodiversity cannot be measured with a single indicator, schemes do exist, such as the EU framework for certifying nature-based carbon removal.⁷⁹



Biodiversity Offsetting

Core mechanism

Offsetting is a voluntary or mandatory instrument for companies to compensate unavoidable negative impact on an ecosystem by funding restoration in another location.

Biodiversity potential: What can be achieved?

- Offsetting is useful if an intervention is deemed unavoidable and the same ecosystem functions can be maintained elsewhere in a spatial context.
- Further, it is especially effective when relocation and habitat restoration provide a feasible solution for local species or impact is measurable in a standardized method.
- Usually, offsetting mechanisms only cover land use change like the sealing through building of infrastructure or settlements, but they could be extended to cover the impact from cultivation.

Safeguards: What needs to be considered?

- In contrast to carbon emissions, biodiversity is locally entangled and cannot be linked to a commodity (see focus box on page 25 on the interrelations of biodiversity and climate change).
- When deciding in favor of offsetting, the mitigation hierarchy should be followed: 1) avoid, 2) reduce, 3) restore locally and like-for-like, and 4) offset elsewhere.
- The “like-for-like” idea is important so that offsetting schemes respect the distinctiveness of local ecosystems.
- Other important principles for the funding of restoration projects are coherence with protection goals and designation principles as well as spatial proximity in case of relocations.
- Finally, timeliness needs to be considered: Alternative habitats need to exist before damage to the original habitat is done and relocation can take place.

External costs (or negative externalities) are negative impacts on biodiversity that are not reflected in current market prices and are therefore not considered in the economic decisions of polluters. They may be incurred from activities causing overexploitation and the pollution of ecosystems (see chapter 4), which impact biodiversity as a whole. These costs, which are currently implicitly borne by society, should be **internalized into economic decision-making** by attaching a tax or levy to economic activities causing negative impacts. The most prominent example is the pricing of CO₂ emissions to mitigate climate change. Currently, a biodiversity or agricultural levy is increasingly being discussed. In contrast to conventional taxes, levies must be spent by the state for a specific purpose. For example, an animal welfare levy is currently under development by the Borchert Commission in Europe. However, to allow the pricing of biodiversity impact, economic activities would need to be ascribed a measurable outcome, such as the loss of threatened species or ecosystem services. Local pilots could serve as examples, but, due to the variety of different impact mechanisms and the local distinctiveness of biodiversity, developing standardized indicators is complex.

5.2.3 Voluntary Corporate Commitments

While regulation is essential for creating a level playing field for all stakeholders, consumers are increasingly demanding that companies and public institutions make voluntary biodiversity commitments. Corporate disclosure, standards, and biodiversity-friendly procurement can yield competitive advantages that also enhance the relative return on investment in biodiversity-positive firms, thus facilitating funding from banks and investors.

Corporate disclosure creates awareness of a sector's footprint and allows stakeholders to assess and influence future activities. Customers and investors are increasingly demanding full ESG disclosure, including **transparency on product supply chains**, as seen in the 2018 call on oil and gas firms for climate-safe business.²⁰ Regulators should also enhance disclosure requirements; for example by extending the current EU reporting on environmental matters for large firms.⁸⁰ Voluntary first movers could induce a virtuous circle of sector-wide disclosure, supported by frameworks like the *Global Reporting Initiative*⁸¹ and the *Global Environmental Disclosure System*,⁸² which have started adopting biodiversity criteria. Obtaining reliable, globally comparable data, however, requires international cooperation (such as through the Convention on Biological Diversity) on regional reporting requirements.

Standards can certify good biodiversity practices to customers and end consumers. However, there is a large variety of standards and labels both in terms of quality and effectiveness. Therefore, companies are advised to obtain guidance; for example from established environmental NGOs. Examples of biodiversity-specific standards include the *Climate, Community & Biodiversity Standards (CCBS)* by Verra and the *Union for Ethical BioTrade certification (UEBT)*.⁸³ Moreover, the *Marine Stewardship Council (MSC)* and *Forest Stewardship Council (FSC)* are common certifications for sustainable marine and forest management. Importantly, standards providers and certifiers need to ensure the reliability of certifications throughout the value chain, including initial extraction or cultivation. Due to provider market fragmentation, public authorities could take the lead to ensure fair, transparent, and reliable certification.

Finally, **biodiversity-friendly procurement** involves specific standards for the biodiversity footprint of production inputs, and may build on supplier reporting. Through strict criteria, large industry players can trigger changes even beyond their own value chain. Additionally, public institutions should switch their procurement first to show a clear commitment. Germany already provides comprehensive guidelines for sustainable procurement, though not yet emphasizing biodiversity.⁸⁴

Finally, as described, companies can voluntarily engage in protection and restoration efforts through corporate land stewardship or company reserves. Details are outlined in the focus box below.



Corporate Land Stewardship

Core mechanism

Companies can voluntarily engage in private land conservation and related restoration projects by acquiring and dedicating land to nature conservation or by paying landowners or leaseholders to conserve land for biodiversity purposes.

A pilot project of “company reserves” was implemented in Oberhavel, Germany, by NABU in cooperation with the European Land Conservation Network (ELCN) and supported by the European Union under the EU-LIFE program: 35 hectares of land were bought by the CEO of a Berlin-based company and dedicated to nature restoration and agroforestry measures.¹⁰⁰



Potential for biodiversity: What can be achieved?

- Company reserves enable active restoration and biodiversity-friendly land use on privately conserved land beyond legal requirements and thus help to achieve biodiversity policy targets. Such voluntary efforts can be incentivized by offering landowners or land users (partial) financial compensation for costs incurred by land use restrictions.
- Companies can gain long-term benefits from land stewardship: By actively contributing to the protection of biodiversity, firms gain in attractiveness towards employees and customers and may use the positive impact for reporting purposes. Future business models could involve the certification of carbon sequestration and other ecosystem functions.

Safeguards: What needs to be considered?

- Companies aiming to engage in voluntary land conservation should ensure compliance with conservation law (like species protection) and coherence with regional conservation priorities.
- Conservation planning on privately protected land should consider local ecosystem needs and interests of land users to ensure ecosystem management sustainable in the long term.
- An extension to participatory arrangements with adjacent landowners or farmers is a feasible option when implementing a company reserve; for example, by sponsoring neighboring farmers for preserving marginal land.

5.2.4 Innovation and Collaboration

Promoting innovation through collaborative technology advancement is a highly promising lever to support the transformative change that is needed to harmonize biodiversity preservation and long-term economic value creation. As new creative solutions are required, innovation needs to be driven by all stakeholders. In all types of projects, success in terms of positive biodiversity impact should be frequently verified and the precautionary principle should guide innovation.

First, the **advancement of biodiversity-friendly technologies** can support the reduction of pressures on biodiversity from economic activities. Biodiversity-safe technology may frequently even provide cost benefits to firms. For example, farmers could soon be able to adopt more biodiversity-friendly and precise cultivation, fertilization, and crop protection methods by using aerial imagery and data analysis to track soil and plant health and pest infestation (see chapter 4). Moreover, innovation may yield tools and even business models for contributing to effective ecosystem protection and restoration. Crucially,

biodiversity-friendly innovation should cater to the premises for biodiversity mentioned in chapter 5.1, including allowing space for nature and diversity on used land.

Second, **innovating for a more circular economy** can address several pressures on biodiversity by reducing overall resource needs and respective interventions in natural ecosystems by extractive and productive activities. Circularity means increasing reusability and biodegradability of end products, improving resource efficiency, reducing emissions and eliminating toxicity, as well as enabling waste recovery and recycling. As shown in the 2020 report *CIRCelligence by BCG – It's Time to Close Our Future Resource Loops*, those advancements not only yield cost efficiencies and thus competitive advantage for circular companies, they also have the potential to significantly reduce future raw material needs.⁸⁵ For example, reusing and recycling electric vehicle batteries can reduce the demand for lithium, cobalt, and other metals, thus avoiding potential deforestation and interference from mining and production sites.

Public funding of research may kickstart innovation efforts and enable contributions from universities and civil society, for example through start-ups. The *Horizon Europe* program is projected to dedicate €100 billion to sustainable innovation.⁸⁶ Banks can support with financing instruments that facilitate the procurement of private funding; for instance, via Green Bonds, which certify environmentally positive projects towards investors.⁸⁷ **Coalitions between industry players, public authorities, and research communities** have the potential to advance biodiversity-friendly innovation by codeveloping innovative solutions, researching future trends, and educating consumers. Companies should encourage collaboration along their value chains to achieve positive impacts beyond their production site. An exemplary coalition is the *UK Plastics Pact*, which aims to increase circularity in plastic packaging.⁸⁸

5.2.5 Information and Education

Currently, many stakeholders still lack a good understanding and sufficient knowledge on biodiversity. Training and education can help all stakeholders, from individuals to large corporations, to better integrate biodiversity in their decision-making. Scientific bodies, funded by firms and public authorities, should invest in creating **new information and data** on the state of biodiversity, its regional needs, and the footprint of different activities. For example, knowing about the economic value of ecosystem services and its components is the basis of gauging investments in nature. Just as important as generating information is **transferring knowledge** on the state of biodiversity, its needs, and guidance for action. Data sources, reports, and information on funders must be publicly available and accessible for peer review, and information needs to reach society unbiased.

Education plays an important role in ensuring a better understanding of what biodiversity really is, what is needed to protect and restore it, and how each person or institution can contribute. Raising awareness of these aspects can nudge changes in consumers' purchasing behavior and lifestyles. For example, labeling and in-store promotions can create strong demand signals for products with a low biodiversity footprint. Regulators, NGOs, and retailers can support this through public awareness campaigns on biodiversity-positive consumption. Campaigns with a relatable message and emotional appeal may broadly anchor an issue in society, as achieved for climate change by the *Fridays for Future* movement. Importantly, such initiatives need a simple narrative, independent fact-checking, and supportive institutions acting as multipliers.

5.2.6 Capacity Building

None of the levers aiming at biodiversity-safe land and sea use and business models can reach scale without capacity-building measures. Supported by the private sector, governments should foster biodiversity-positive regional development and help especially low-income regions overcome production patterns that conflict with nature. For this purpose, they in particular need to establish **physical and digital infrastructures** which improve people's access to education and markets.

Beyond the infrastructural support, stakeholders can empower each other through **impact measurement and guidelines** for action. Business associations and NGOs should advance customizable impact measurement tools to help firms and consumers assess their biodiversity footprint. Specific measurement methods on biodiversity impact are particularly important to monitor and transparently report on target achievement. Many universal frameworks are in development, including the *Science-based Targets for Nature* project⁸⁹, the *Natural Capital Protocol*⁹⁰ and an EU project for natural capital accounting.⁹¹ Through guidelines, stakeholders can spread low-cost, biodiversity-positive practices. One example of that is the cooperative initiative for *Community-Based Natural Resource Management (CBNRM)* through which forestry companies and other stakeholders can share knowledge of locally suitable harvesting and cultivation practices.⁹² Consumers, meanwhile, should be equipped with guidelines for household resource and waste management, and options for local biodiversity support.

In many areas, rapid economic development collides with the integrity of delicate ecosystems and biodiversity hotspots, including tropical forests in Central Africa, Asia, or Latin America. Projects should be established to help nations located there to leapfrog traditional industrialization and adopt modern, greener business models. Thus, industrial nations can support those efforts through **targeted foreign aid and cooperation**, which helps to align macroeconomic interests with biodiversity and catalyze the transition towards a biodiversity-positive economy. The *UNDP BIOFIN* initiative⁹³ and the *Global Environment Facility (GEF)*⁹⁴ are examples of programs that initiate, fund, and support protection and restoration projects. Regionally focused alliances can add to these efforts, such as a biodiversity alliance for Africa, as suggested by the Leopoldina academy.³⁹ Importantly, funds need to be controlled, especially in unstable political situations.

5.3 Opportunities for Stakeholders to Act

Crucially, biodiversity preservation needs to be orchestrated by regulators and to a large extent implemented by the private sector. Commitments should be ambitious and followed by coordinated action, spanning across regions, stakeholders, and sectors to ensure lasting change. Yet, as our analysis shows, the responsibility to harmonize biodiversity with economic and social prosperity cannot be solely placed with local businesses and landowners. Diverse ecosystem requirements and complex, interdependent supply chains must be considered when evaluating preservation options—and all stakeholders must contribute. Figure 10 provides a checklist of the most accessible and impactful options for action per stakeholder.

In particular for **companies**, strategically acting on biodiversity can mitigate risks, yield benefits, and strengthen business resilience for the future. To start with, addressing a company's own biodiversity impact helps to mitigate the physical and systemic risks of ecosystem services loss. This is especially important to industrial and primary sectors that benefit from provisioning functions, such as agriculture, forestry, and fishery, but also for tourism, which depends on nature's recreational value. In the face of increasing public awareness, a company's negative biodiversity impact may additionally involve regulatory and reputational risks. Those companies not complying with expectations may be subject to fines, sanctions, declining revenues, and increased funding costs. On the other hand, companies engaging in biodiversity protection and restoration can benefit in four ways. First, by fostering the value proposition of existing products and services through certified biodiversity standards and full disclosure. Second, by expanding to new markets or business fields with a biodiversity-friendly product portfolio. Third, by optimizing production processes, for example through increased circularity. And fourth, by addressing the increasing environmental priorities of consumers and investors and improving the firm's attractiveness as an employer.

Opportunities for All Stakeholders to Take Action on Biodiversity








 Companies	 Citizens/ consumers	 NGOs	 Investors	 Public authorities	 Scientific communities	 Media
<ul style="list-style-type: none"> • Measure and disclose biodiversity impact • Adopt biodiversity-friendly standards and drive change in value chain • Develop innovative concepts and solutions • Financially support protection and restoration • Lobby for legal certainty and level playing field • Raise biodiversity awareness among employees, suppliers, and customers 	<ul style="list-style-type: none"> • Reduce unsustainable consumption and track own footprint • Purchase and demand certified biodiversity-friendly products • Donate for protection and restoration activities 	<ul style="list-style-type: none"> • Initiate protection and restoration activities • Develop new concepts and common visions for the future • Gather knowledge and raise awareness • Initiate calls to action, campaign and lobby for policy changes 	<ul style="list-style-type: none"> • Adopt biodiversity-friendly investing criteria and divest from harmful activities • Initiate calls for action • Invest in projects and firms with disclosed positive biodiversity impact • Create supportive financial instruments 	<ul style="list-style-type: none"> • Coordinate protection and restoration • Create economic incentives and educate industry and consumers • Set legal frameworks and conditions for a level playing field, and control companies' activities even beyond own country borders • Foster innovation through public funding of research • Mediate between stakeholders 	<ul style="list-style-type: none"> • Create and communicate new insights on biodiversity state, needs, human impact, and options for action • Enable measurement of biodiversity impact • Support monitoring of project effectiveness 	<ul style="list-style-type: none"> • Communicate insights on biodiversity state, needs, human impact, and options for action • Raise awareness on support-worthy projects • Observe, analyze, and communicate about policy-making and private-sector activities • Follow up and put pressure on non-compliant actors

Figure 10: Stakeholders' opportunities to take action on biodiversity.

Note: List of options is not exhaustive.

Source: BCG; NABU



6. The Time for Collaborative Action Is Now

» Goals for conserving and sustainably using nature [...] may only be achieved through transformative changes across economic, social, political, and technological factors.

Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019

Biodiversity is essential to the stability of our planet and for resilient societies. Yet, the intactness of biodiversity and the services it provides are at risk, declining at an unprecedented pace. The good news: We already have the knowledge and tools to drive a global turnaround.

Given the complexity and interdependence of natural ecosystems, business as usual can trigger unpredictable and potentially irreversible consequences. Continued biodiversity loss exposes society to the risk of gradual ecosystem collapse. Already today, the annual cost of inaction amounts to at least \$6 trillion of foregone ecosystem services, a loss in excess of most countries' annual economic value generation. The accelerated extinction of threatened species additionally brings an unquantifiable loss of intrinsic value and opportunities for future generations.

If we systemically and collectively adopt the levers outlined in this report, we can achieve more than just preserving nature. Restoring lost ecosystem functions will unleash trillions of dollars in benefits for society from services like disaster mitigation, pollination and biological pest control, water treatment, or soil fertility. Through carbon sequestration, healthy ecosystems can be a major contributor in the fight against climate change. Moreover, by internalizing biodiversity in economic decisions, we can take a step towards harmonizing economic, social, and environmental matters.

This report calls for all stakeholders to join forces in the common interest of preserving biodiversity by asking the following questions:

- How can we individually and collectively contribute to tackling this global crisis?
- How can we ensure a just transition to biodiversity-safe practices?

Regulatory intervention and policy steering are indispensable. Still, public authorities cannot solve this crisis on their own. Consumers, producers, investors, and local communities alike—we all need to question and address our roles. The future of our planet depends on immediate and decisive action to preserve biodiversity in all its richness.

The time for change is now!

Appendix

Methods of Economic Valuation of Ecosystem Services

As outlined in chapter 2.3, we have estimated the global value of ecosystem services based on the *Ecosystem Service Value Database*, which was developed between 2007 and 2014 by the research group around R. Costanza and R. de Groot for the international initiative *The Economics of Ecosystems and Biodiversity (TEEB)*. Ecosystem service value is defined as the contribution of the assets of nature at a specific point in time.

In order to make the results comparable to current markets, we conducted the analysis in three major steps.

1. We adjusted all values for inflation to current dollar units, based on the average global inflation rate from the World Bank.
2. We developed updated estimates for provisioning services from forests, croplands, grasslands, and oceans with current market sizes and EBITDA margins. The discounting of revenues is necessary to reach the actual value of raw materials provided by each of these ecosystems.
3. We recalculated the values for the climate regulation service based on a CO₂ price of \$202 (€180) per ton, which represents the recommended value by the German Environment Agency⁹⁵ to account for externalities of carbon emissions.

Table 1 summarizes all assumptions made for these steps. Importantly, our calculation does not account for any losses in ecosystem service value incurred since the conduction of the TEEB study. Moreover, the stated value is a static representation of the latest measurements and assumptions, not accounting for fluctuations in ecosystem functionality and market dynamics, which continually impact the economic worth of biodiversity.

The following limitations should be considered when conducting a monetary assessment of ecosystem services and biodiversity. Foremost, economic valuation must be interpreted with caution, as monetary units only cover anthropogenic benefits of biodiversity. Their evaluation is often difficult, partly because we cannot be fully aware of potential benefits for future generations, and partly because the perception of value is subject to current market dynamics. Furthermore, it must be noted that the true value of ecosystem services deviates from the price of these services for two reasons. First, because many aspects of them are currently not accounted for in economic systems, and second, because ecosystem services are unnegotiable and irreplaceable.

In order to derive the value of ecosystem services lost annually, as mentioned in chapter 2.4, we assumed that the share of 3–15% of losses from total ecosystem service value has remained the same as in R. Costanza. By adjusting their original \$4 trillion–20 trillion to current terms, we reached an estimate of about \$6 trillion–30 trillion in annual losses.

Methods of Valuation for the Impact of Economic Activities

In chapter 4 we estimate the shares of economic activities in the pressure on biodiversity and the associated loss of ecosystem services. Since biodiversity is locally distinct, existing studies focus on the contribution of activities to the decline of certain ecosystems, such as forests. Our analyses are based on the best available data to enable aggregation on a global level.

In the analysis shown in figure 7, we focus on the share of major economic activity groups (farming, forestry, etc.) in total pressure on biodiversity. Our analysis involves three steps and several assumptions shown in table 2:

1. Determine the contribution of economic activities to the major pressures on four biodiversity components: a) overall wildlife, b) marine ecosystems, c) terrestrial ecosystems, and d) freshwater

Category	Type	Valuation approach	Value	Assumptions/comments	Source
Unit values	International dollars	Inflation adjustment of 2007-\$ values to 2019-\$ values by considering average inflation rate	3.4%	<ul style="list-style-type: none"> Based on Constanza, normed "2007 international \$/year" values Average global inflation rate from 2007–2019 	1, 2
Climate regulation	Open oceans, forests	Average carbon sequestration rate (tCO ₂ /ha)	Per ecosystem	<ul style="list-style-type: none"> Temperate forests 1.5 tC/ha, Tropical forests 10 tC/ha Converted to tCO₂ with conversion factor of 3.67 Oceans: based on results from BCG study on oceans ability to absorb CO₂ in t CO₂/ha 	3, 4
		CO ₂ price which accounts for externality costs (\$/tCO ₂)	202	Value refers to required CO ₂ price which internalizes the external costs arising from CO ₂ emissions (\$180/tCO ₂)	5
Provision of raw materials	Tropical, temperate, and boreal forests	Annual revenues from global wood, fiber and nonwood forestry products (\$)	Per forest type	<ul style="list-style-type: none"> Global revenues per forest and product type 	6
		EBITDA margin (%)	Avg. 13%	<ul style="list-style-type: none"> Discounting of revenues necessary to reach value of raw materials provided by forests 	6
Provision of food	Cropland	Total global agricultural revenues (T\$)	2.6	<ul style="list-style-type: none"> Gross production value of agriculture minus value from livestock production, as we assume that livestock production is no inherent ecosystem service FAO \$2.4T value in 2016-\$ inflation adjusted to 2019-\$ 	7, 2
		EBITDA margin (%)	Avg. 25%	<ul style="list-style-type: none"> EBITDA margins of global agriculture/farming sectors at 7%, assuming a share of 25% which includes seed and fertilizer inputs from nature Share of natural inputs in agricultural products is high and strongly fluctuating 	
	Grasslands	Total food provisioning (\$)	0	<ul style="list-style-type: none"> We assume that grasslands do not offer additional food provisioning (other then considered in croplands) Livestock production is not considered as ecosystem service 	
	Open oceans, coasts	Total global revenues from marine food production (T\$)	0.43	<ul style="list-style-type: none"> Sales value of marine fish (capture and aquaculture) in 2016 inflation adjusted to 2019-\$ 	8
EBITDA margin (%)		Avg. 25%	<ul style="list-style-type: none"> Discounting of revenues necessary to reach actual value of raw materials offered by each ecosystem Assuming EBITDA margin from in agricultural sector to be about the same for fisheries 		
Provision of genetic and medical resources	All ecosystems	Adaption of Costanza revenue values to net value	Per ecosystem	<ul style="list-style-type: none"> Values from Costanza include net worth of products and an option valuation of potential future revenues 	1
		EBITDA margin (%)	Avg. 26%	<ul style="list-style-type: none"> EBITDA margin of agricultural products, global aggregated average of last three years 	6
Air purification	Forests	Based on BCG forest paper approach: Rate of air pollutant removal (t/ha)* Costs per ton of pollutant (\$/t)* Recreational forest area (M ha)		<ul style="list-style-type: none"> Forests reduce pollution costs by absorbing odors and pollutant gases and filtering particles from the air Including PM2.5, NO₂, SO₂, O₃ Air purification service occurs mostly in areas close to human settlements, which are recreational forests areas 	6

Source: BCG analysis based on:

- 1 Costanza, Robert, et al., 2014: "Changes in the global value of ecosystem services." Global environmental change 26: 152-158.
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Table 1: Assumptions for the economic valuation of ecosystem services

ecosystems. Each of these components were assigned a key indicator of pressure on biodiversity health. Table 2 shows the indicator applied per ecosystem type and lists the dominant activities causing these pressures. We then aggregated the results under the assumption of equal weighting of the four components.

2. Calibrate the output by the implied distribution of economic activities as the drivers of the five big pressures on biodiversity. This was done by comparing the aggregate distribution resulting from step 1 with literature on the contribution of economic activities to the five pressures (such as IPCC data on the shares of economic activities in climate change⁴² or the contribution of economic activities to pollution). This provided the basis for the analysis of each activity's contribution to the five pressures (flames in figure 7). In addition, we validated the resulting assessment with experts from science, conservation work, and industry.
3. Calibrate the results by comparing the implied overall split between the five pressures to the shares mentioned in IPBES (2019), which features the area-based split for the terrestrial, freshwater, and marine ecosystems.²

Biodiversity component	Indicators of pressure on biodiversity	Major contributors	Sources
Terrestrial ecosystems	<ul style="list-style-type: none"> • Contribution to deforestation (50%) • Contribution to forest and soil degradation (50%) 	<ul style="list-style-type: none"> • Farming (~ 40%) • Forestry (~ 20%) • Infrastructure (~ 15%) • Mining (~ 5%) • Energy (~ 5%) • Transportation (~ 5%) • Other, incl. consumer activities and subsistence (~ 5%) 	1, 2, 3, 4, 5
Freshwater ecosystems	<ul style="list-style-type: none"> • Overall threats to freshwater habitats based on Living Planet Index • Contribution to threats (habitat loss, over-exploitation, climate change, pollution) 	<ul style="list-style-type: none"> • Farming (~ 30%) • Fishing incl. aquaculture (~ 30%) • Energy (~ 10%) • Mining (~ 10%) • Industry (~ 10%) • Other, incl. consumer activities and infrastructure (~ 5%) 	6, 7, 8, 9, 10
Marine ecosystems	<ul style="list-style-type: none"> • Overall threats to marine habitats based on Living Planet Index • Contribution to threats (habitat loss, overexploitation, climate change, pollution) 	<ul style="list-style-type: none"> • Fishing incl. aquaculture (~ 70%) • Farming (~ 10%) • Consumer activities (~ 5%) • Transportation (~ 5%) • Other, incl. energy and industry (~ 10%) 	6, 7, 8, 10, 11
Wildlife overall	<ul style="list-style-type: none"> • Species affected by different threats based on the IUCN Red List 	<ul style="list-style-type: none"> • Farming (~ 30%) • Forestry (~ 15%) • Infrastructure (~ 15%) • Industry (~ 15%) • Fishing incl. aquaculture (~ 10%) • Consumer activities (~ 5%) • Other, incl. transportation and energy (~ 10%) 	6, 8, 12

Source: BCG analysis based on

- 1 Hosonuma et al., 2012: "An assessment of deforestation and forest degradation drivers in developing countries". Environmental Research Letters
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Table 2: Methods of estimating economic activities' shares in pressures on biodiversity.

Note: Numbers rounded.

Source: BCG analysis

In the case study on the decline of ecosystem service values (see chapter 4), we estimate the impact of farming activities on different ecosystem services. The approach has two steps:

1. Define the main ecosystems affected by farming and estimate their annual loss in functionality based on an estimate of percentage area affected (100% for croplands, 10–50% for surrounding forests, grasslands, freshwater, and coastal ecosystems), and an estimated percentage annual loss in functionality on the area affected.
2. Multiply the results with the value of ecosystem services per ecosystem, assuming a proportional decline in ecosystem service value, as suggested by Costanza et al. (2014). Since ecosystem service values differ by ecosystem, this step returned both the relative and absolute decline of ecosystem service values.

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NABU

Founded in 1899, NABU (Nature And Biodiversity Conservation Union), is one of the oldest and largest environmental associations in Germany. The association encompasses more than 770,000 members and sponsors. NABU's most important tasks are the preservation of habitat and biodiversity, the sustainability of agriculture, forestry and water management and, last but not least, climate protection. The communication of nature experiences and the promotion of natural history knowledge are among NABU's central concerns.

About 40,000 volunteers play an active role in practical nature conservation work, with great success: This is something that is unique to NABU. These active NABU members look after more than 110,000 hectares of valuable protected reserves in Germany. NABU also has volunteer groups working on an international level to conserve nature and combat poverty in Africa, Eurasia, and the Caucasus. This work is supported by professionals at our regional offices and at our national headquarters in Berlin, who take care of public relations, project development and management, and political lobbying. NABU is part of BirdLife International. www.NABU.de

BirdLife International

BirdLife International is the world's largest nature conservation partnership. Together we are over 100 BirdLife Partners worldwide—one per country or territory—and growing. BirdLife's vision is a world rich in biodiversity, where people and nature live in harmony. We use birds as the best ambassadors of nature and our science guide our actions. We are driven by our belief that local people, working for nature in their own places but connected nationally and internationally through our global Partnership, are the key to sustaining all life on this planet. This unique local-to-global approach delivers high impact and long-term conservation for the benefit of nature and people.

We believe that a healthy planet should be a universal human right. Please visit <https://1planet1right.org> to discover what we are doing to make this so, and how you can get involved. www.birdlife.org

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