



The dual climate & biodiversity crises

A perspective for donors

Sebastian Schienle, October 2024

“Repairing relations with Mother Earth is the mother of all of humanity’s challenges. We must act — and act now — to create a better future for us all.”

UN Secretary-General António Guterres

Key messages

- Biodiversity supports human well-being and provides enormous economic value – more than half of global GDP relies on it.
- Healthy ecosystems are also inextricably linked with efforts to combat climate change. Nature provides an important buffer against anthropogenic greenhouse gas emissions and global warming.
- Yet, biodiversity is in steep decline. Human actions have changed most of the Earth's land and oceans. The number of species going extinct is much higher than it has been for the last 10 million years.
- Land-use change via agriculture and the overexploitation of natural resources via harvesting, logging, hunting and fishing have had the biggest negative impact on ecosystems during the last 50 years. Climate change is increasingly adding pressure.
- Our current economic system continues to damage the environment. For every \$1 spent on conserving nature, \$35 is spent harming it.
- Philanthropy can play an important role in protecting and restoring biodiversity. Environmental philanthropy has been growing fast in recent years, but from a low base.
- Perhaps more importantly, what is spent is not allocated to have the greatest impact.
- We believe a different approach is needed for effective philanthropy that places a stronger emphasis on levers to multiply impact and systemic change.
- Further research is needed, but we consider four impact areas particularly promising based on our shallow review:
 1. Accelerating the development of alternative proteins to replace conventional meat, a key driver of the ongoing conversion of nature.
 2. Creating supply chain transparency to expose links to deforestation and increase corporate accountability.
 3. Using the law and strategic litigation to strengthen conservation and hold polluters accountable.
 4. Protecting and restoring wetlands, one of the most biodiverse and carbon-rich ecosystems.

Contents

Key messages	1
Contents	2
Introduction	3
The value of (protecting) biodiversity	3
What do we mean by biodiversity?	3
The different values of nature	3
Biodiversity and climate change	4
Nature in decline	6
Five drivers of biodiversity loss	8
Land-use change	8
Natural resource use	9
Climate change	9
Pollution	10
Invasive species	10
Philanthropic support for biodiversity	11
Current funding	11
Finance needs	12
Impact focus	13
How we think about effective giving for nature	14
Key considerations	15
Conservation versus restoration	15
Nature, climate and socio-economic co-benefits	16
Which types of ecosystems should be prioritized?	17
How to multiply your impact	18
Four promising fields that we have identified	19
Alternative proteins	19
Supply chain transparency	20
The law	21
Wetlands	22
References	24

Introduction

While climate change and the push to phase out fossil fuels dominate global discussions, the biodiversity crisis often receives far less attention, despite its equally profound implications. High-impact giving for conservation and biodiversity is more important than ever as species extinction rates soar and ecosystems face unprecedented threats.

Investing in biodiversity preservation can yield lasting benefits for the planet. It protects natural systems that support human life and help to limit climate change. Yet, little guidance exists on how to make the most out of philanthropic donations to support biodiversity. This report explains why biodiversity is important, what philanthropic support is currently available, and how donations can have a bigger impact. We hope that this report will encourage people to think carefully about how to allocate scarce philanthropic resources to support biodiversity, and that it will motivate further funding and research into the most promising giving opportunities.

The value of (protecting) biodiversity

What do we mean by biodiversity?

Biological diversity, or biodiversity for short, is the variety of life. The Convention on Biological Diversity (CBD) [defines biodiversity](#) as “*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.*” Biodiversity therefore describes three different components – genetic diversity, species diversity, and ecosystem diversity – and applies in reference to different geographical scales (local, national, regional, global).

This also includes an element of abundance, i.e. how many specimens of a species exist, where they are present, and how their populations evolve. This is what the WWF’s [Living Planet Report](#) tracks or the decline in insects we observe as the “[windshield phenomenon](#)”. For us, protecting biodiversity encompasses all of the above, always in the context of functioning ecosystems and the value they provide.

The different values of nature

The Kunming-Montreal Global Biodiversity Framework (GBF) [describes](#) biodiversity as “*fundamental to human well-being, a healthy planet, and economic prosperity for all people [...]. We depend on it for food, medicine, energy, clean air and water, security from natural disasters as well as recreation and cultural inspiration, and it supports all systems of life on Earth.*”

This definition encapsulates the broad set of different values attached to biodiversity and functioning ecosystems. Beyond the *intrinsic* value of nature, the *spiritual* value of ecosystems is reflected in many religious writings, such as Islam’s concern for natural surroundings ([Hamim et al. 2023](#)), or as expressed in Pope Francis’ encyclical letter “[Laudato si’](#)”. The importance of nature for Indigenous peoples is also well documented (e.g., [Chatterjee et al. 2022](#), [UNEP 2017](#)).

We enjoy nature’s *recreational* value every time we explore the outdoors and go hiking, swimming or sailing. Multiple studies suggest that beyond joy and recreation, time spent in nature also provides direct benefits to human health, including improved general health, mental well-being, immune functioning, and stress reduction (e.g., [Pritchard et al. 2020](#); [Capaldi et al. 2014](#); [Martin et al. 2020](#); [Keaulana et al. 2021](#)).

By providing clean air, fresh water, food etc. — what we call ecosystem services — nature also provides enormous *economic* value. An estimated \$44 trillion of economic value generation, more than half of global GDP, is moderately or highly dependent on nature. ([WEF 2020](#)) The direct dependencies and risks to industries such as agriculture, food & beverages, or construction are straightforward to grasp. But many industries also have “hidden dependencies” through their supply chains. In industries such as chemicals and materials, or retail and consumer goods, more than half of their supply chains’ gross value added is highly or moderately dependent on nature. This dependency can also be thought of as a hidden liability on our global balance sheet: while we grew global GDP per capita by more than 60% between 1992 and 2014, we depleted natural capital stocks per capita by nearly 40%. ([Dasgupta 2021](#)) In effect, we’re facing a tragedy of the commons — we’re overusing a resource that is largely free and unaccounted for in our economic system. The World Economic Forum’s annual Global Risks Perception Survey reveals the associated risks. The top four global risks by severity over a 10-year period are all environmental, including “critical change to Earth systems” as number 2, and “biodiversity loss and ecosystem collapse” as number 3. ([WEF 2024](#))

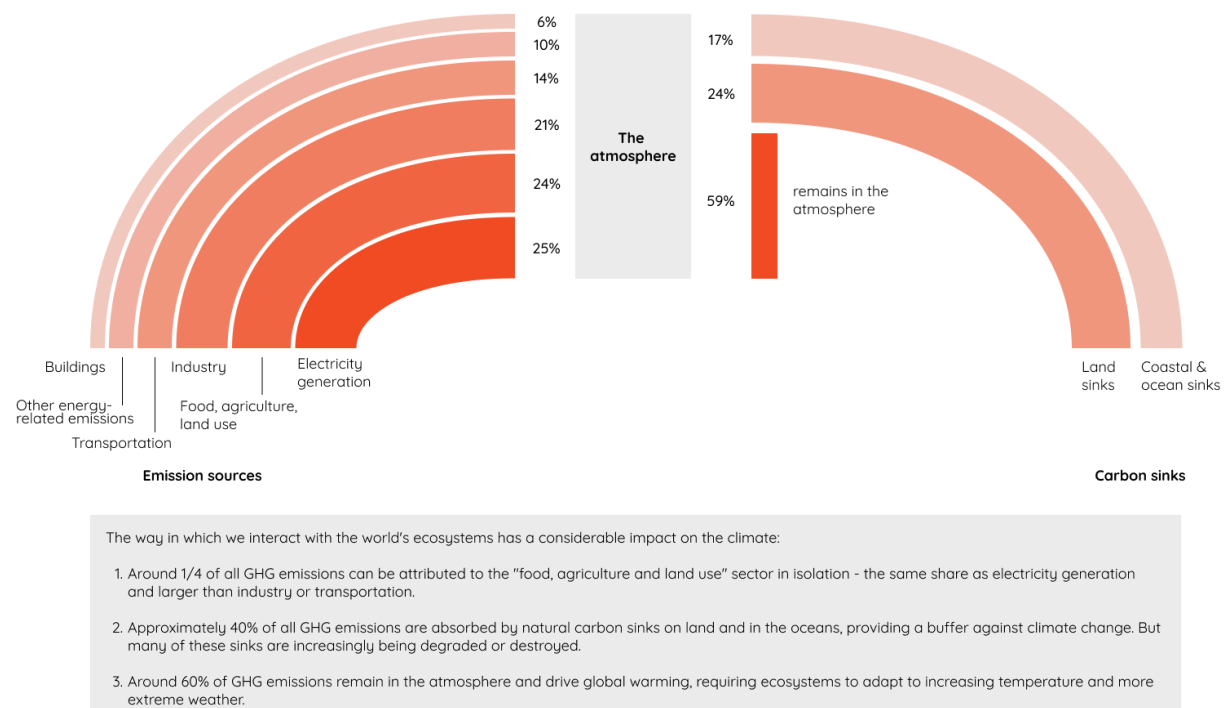
Biodiversity and climate change

Functioning ecosystems are also inextricably linked with climate change. Nature can both be a driver of and buffer against global warming. Land conversion and nature degradation are a major source of greenhouse gas (GHG) emissions, whereas intact ecosystems can act as carbon sinks. Nature degradation thus has a double impact on climate change: first, by emitting carbon from the plants that are lost, and second, by reducing the capacity of the ecosystem to absorb carbon dioxide.

The scale of nature’s buffering capacity is often overlooked: The Earth’s land-based ecosystems and oceans currently absorb ~40% of all anthropogenic GHGs (leading to ocean acidification). This significantly reduces the amount of emissions that remain in the atmosphere and that drive global warming. (See Figure 1, [Tonsmeier et al. 2020](#). See

also [Friedlingstein et al. 2023](#)) In addition, oceans have also absorbed nearly 90% of the warming that has occurred in recent decades due to increasing GHG emissions. ([von Schuckmann et al. 2023](#)) Accordingly, without nature's buffering capacity, climate change would already be significantly worse. In effect, we would have already exceeded the 1.5°C threshold. But this buffering capacity appears to be increasingly [at risk](#), both as a result of human impacts and the adverse effects of climate change on ecosystems.

Figure 1 - GHG Emissions and Sinks (adapted from [Tonsmeier et al. 2020](#))



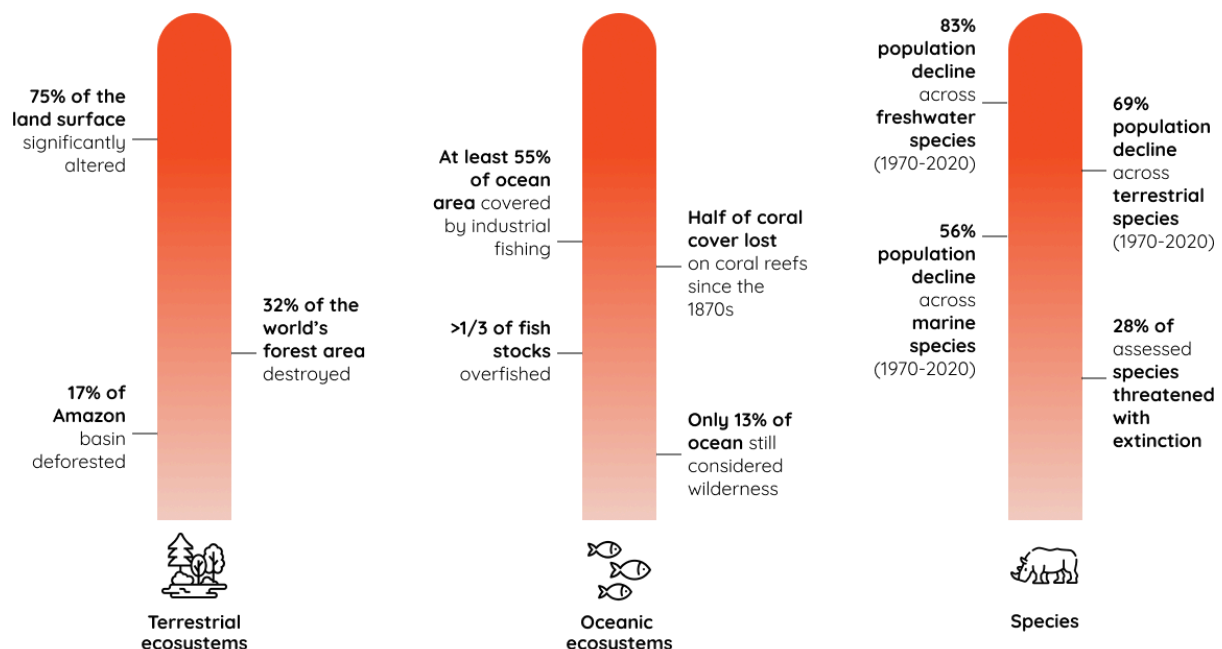
The Amazon rainforest, one of the most biodiverse places on earth, exemplifies the interdependence and mutual reinforcement between functioning ecosystems and climate change. It is considered a [tipping element](#), i.e. a critical, large-scale component of the Earth system characterized by a threshold behavior — in the case of the Amazon, it's forest dieback, i.e. drying up and turning into savannah. The Amazon has been a large carbon sink and its ["flying rivers"](#) are a critical component of Latin America's water cycle. However, recent scientific studies have shown that parts of the Amazon now already emit more carbon into the atmosphere than they absorb. ([Basso et al. 2023](#), [Gatti et al. 2021](#), [Harris et al. 2021](#)) The current best estimate for the tipping point of Amazon dieback is at around 3.5°C (2-6°C) of global warming, without considering the impacts of deforestation, however. ([Armstrong McKay et al. 2022](#)) If that is also taken into account, the combined effects of global warming of 1.5-2°C and a loss of 20-25% of the Amazon may be sufficient to trigger irreversible Amazon dieback — not very far from the 1.2°C of warming and ~17% of forest loss we have already reached. ([Flores et al. 2024](#), [Lovejoy & Nobre 2019](#))

The Planetary Boundaries Framework, a concept developed by a network of leading earth system scientists which identifies nine interrelated processes that are critical for maintaining the stability and resilience of our planet, considers functioning ecosystems (“biosphere integrity”) and the climate the “core” boundaries. (Steffen et al. 2015) And the joint IPBES-IPCC workshop on biodiversity and climate change with 50 of the world’s leading experts concludes that “The mutual reinforcing of climate change and biodiversity loss means that satisfactorily resolving either issue requires consideration of the other.” (Pörtner et al. 2021) If we don’t simultaneously phase out fossil fuels and address the biodiversity crisis, we will be unable to limit global warming to the targets set in the Paris Agreement and risk further destabilizing our planet.

Nature in decline

Despite the value that biodiversity and functioning ecosystems provide, the world invests close to \$7 trillion globally each year in activities that have a direct negative impact on nature, for example including environmentally harmful agriculture and fossil fuel subsidies, but also private investments in industry, basic materials, or the energy sector. (UNEP 2023) Human actions have already significantly altered three-quarters of the world’s land-based environment and about two-thirds of the marine environment.

Figure 2 – Human impacts on nature’s decline



Sources: FAO 2024; IPBES 2019; IUCN 2024; WWF 2024

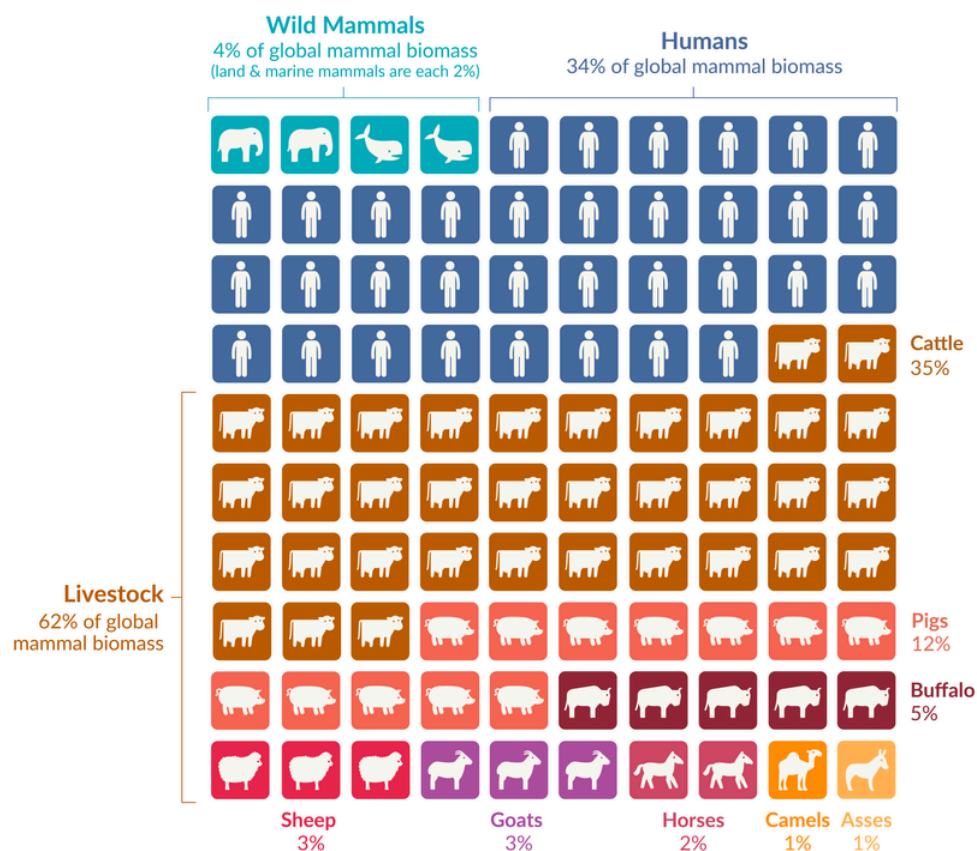
As a result, the global rate of species extinction is at least tens to hundreds of times higher than it has averaged over the past 10 million years, with a million species facing extinction, many within decades. (IPBES 2019) According to the latest scientific assessments, 28% of assessed plant and animal species are threatened. (IUCN 2024) Wildlife populations around the world have declined by 73% on average between 1970 and 2020. (WWF 2024) Today, wild mammals make up just 4% of the world's mammal biomass. (See Figure 3, Ritchie 2022; see also Ritchie 2021a)

Figure 3 - Distributions of mammals on Earth

Distribution of mammals on Earth

Mammal biomass is measured in tonnes of carbon, and is shown for the year 2015. Each square corresponds to 1% of global mammal biomass.

Our World
in Data



Note: An estimate for pets has been included in the total biomass figures, but is not shown on the visualization because it makes up less than 1% of the total.

OurWorldinData.org — Research and data to make progress against the world's largest problems.

Licensed under CC-BY by the authors
Hannah Ritchie and Klara Auerbach.

The latest science on planetary boundaries suggests that the biosphere integrity boundary has already been transgressed in both its functional and genetic components, i.e. we're already at a point that puts at risk the biophysical stability of the Earth system. (Richardson et al. 2023)

Five drivers of biodiversity loss

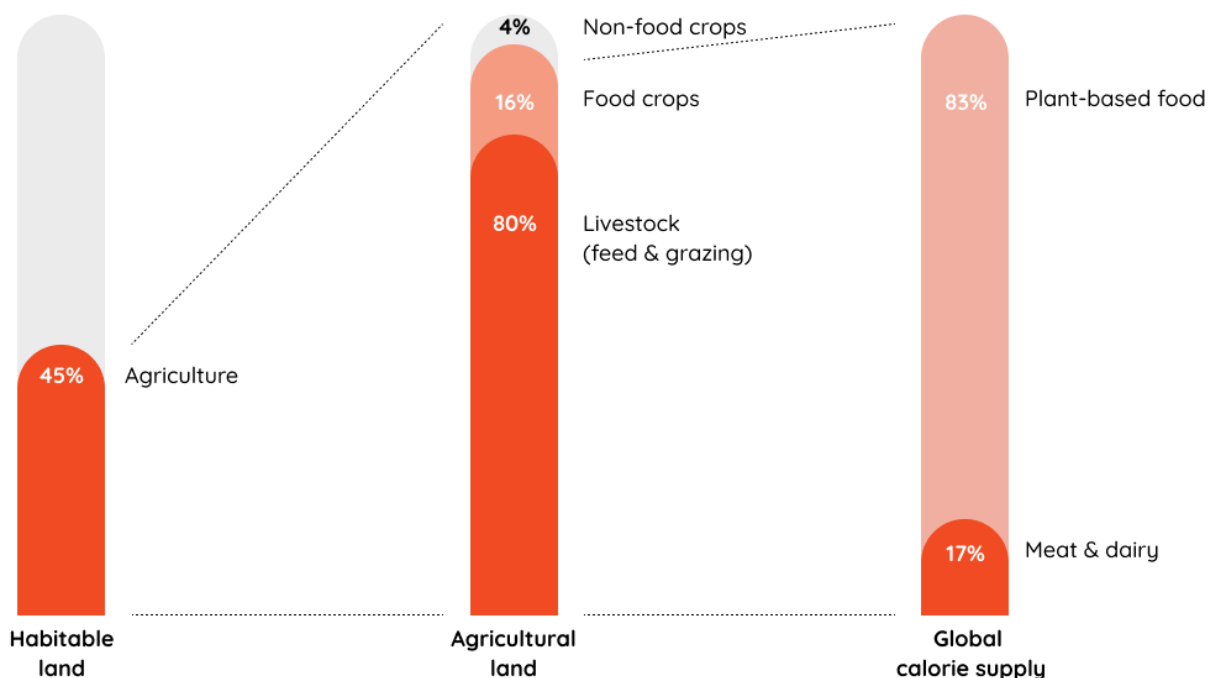
The latest report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) – the most comprehensive global biodiversity assessment to date – identifies five direct drivers of change in nature that have accounted for more than 90% of nature loss in the past 50 years ([IPBES 2019](#)). It calls the rate of change over this period “unprecedented in human history”.

Globally, land-use change, driven by agricultural expansion, has had the largest negative impact on terrestrial and freshwater ecosystems since 1970, followed by overexploitation via harvesting, logging, hunting and fishing. In the oceans, the exploitation of fish and seafood has had the largest relative impact. Climate change, pollution and invasive species have had a lower relative impact to date, but are accelerating. Ultimately, all five drivers stem from human activity.

Land-use change

Globally, the way in which people use the land has been the driver with the largest relative impact. In 1750, less than 10% of the world’s habitable land was used for agriculture. Today, agriculture uses about half of the world’s habitable land. (See Figure 4; [Klein Goldewijk et. al 2017](#)) (In contrast, urban and built up land makes up only 1%.)

Figure 4 – Global land use for food production (based on [Ritchie & Roser 2024](#))



Strikingly, only 16% of agricultural land is used to grow food crops. 80% of the area is used to raise and feed livestock – a highly inefficient way to produce human calorie supply. (And more than [80 billion farm animals](#) are slaughtered every year as a result.)

Agricultural land use has necessarily led to the conversion of large parts of natural forest, grasslands, and wetlands. Somewhat surprisingly, land use for agriculture appears to have peaked at the global level. ([Taylor and Rising 2021](#), see also [FAOSTAT](#)) But this isn't true for every part of the world. Projections still indicate large increases in agricultural land – and corresponding pressure on nature – in sub-Saharan Africa, South and Southeast Asia, and South America. ([Williams et al. 2020](#)) Despite some progress in fighting deforestation, the world still lost 3.7 million hectares in tropical primary forest in 2023, the equivalent of losing almost ten soccer fields of forest per minute. ([WRI 2024](#))

Natural resource use

The overexploitation of plants and animals, through hunting or poaching for example, is another reason we are losing biodiversity. Direct exploitation of fish and seafood has had the largest relative impact in the oceans since 1970. More than a third of all monitored global fish stocks are now overfished. ([FAO 2024](#)) The use of natural resources – from food crops, fodder, wood, wild catch, and harvest to the extraction of fossil fuels, metals, and minerals has increased more than three times since 1970 and continues to grow. ([UNEP 2024](#))

Climate change

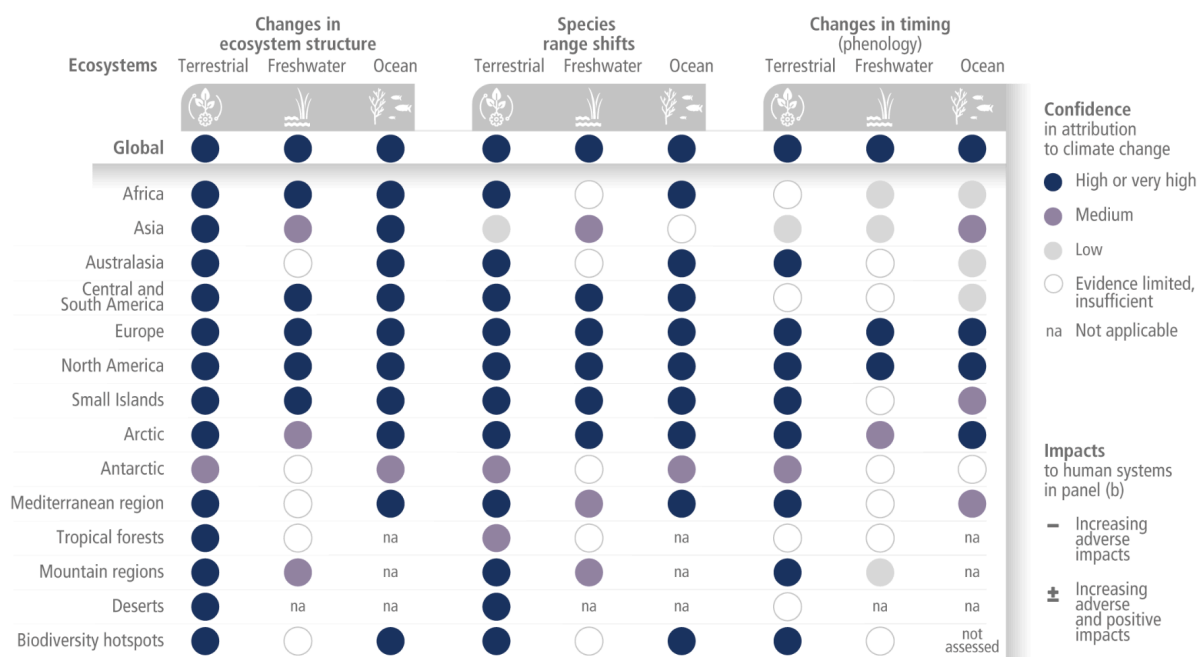
Increased surface and ocean temperatures, changing precipitation patterns, and increased frequency of extreme weather events as a result of higher greenhouse gas (GHG) concentrations all adversely affect biodiversity, in turn negatively impacting nature's ability to act as a buffer against climate change. Climate change has already caused substantial damages, and increasingly irreversible losses, across different types of ecosystems. (See Figure 5, [IPCC 2022](#))

Between 2009 and 2018, we lost about 14% of the coral from the world's coral reefs, for example. Coral reefs support at least 25% of marine species and are critical for the coastal protection, food, and economic security of hundreds of millions of people. ([Souter et al. 2021](#)) They are projected to decline by a further 70 to 90% – i.e. effectively disappear – already at 1.5°C global warming. ([IPCC 2018](#))

In forests, climate change has increased tree mortality, both directly through increased aridity and droughts and indirectly through increased wildfires and insect pests in many locations. ([IPCC 2022](#))

Figure 5 – Observed impacts of climate change on ecosystems

(Figure SPM.2 in IPCC 2022)



Pollution

Pollution comes in many forms, ranging from nitrogen and ammonia pollution, caused by intense agriculture, to microplastics found in the deepest parts of the ocean. It has reached all types of ecosystems, even those in remote areas.

For example, 22 million tonnes of plastic waste leak into the environment every year. (OECD 2022) Today, microplastics, i.e. plastic materials smaller than 0.5 centimeters in diameter, are ubiquitous — they have been detected everywhere from the summit of [Mount Everest](#) to the bottom of the [Mariana Trench](#), in [human blood](#) and even in [dolphin breath](#). While we still lack comprehensive evidence of the impacts on human health (WHO 2022), multiple studies have shown that microplastics are harmful to aquatic organisms, cause structural damage in fish, and cause dysfunctions in the intestine, liver, and excretory and reproductive systems in mice and rats. (Zolotova et al. 2022)

Similarly, around 120 million metric tons of synthetic nitrogen fertilizers are applied globally every year. But only around 35% of this is used by crops – the remainder runs off into our rivers and lakes (Ritchie 2021b), leading to eutrophication which causes harmful algal blooms, dead zones, and fish kills. (Chislock et al. 2013)

Invasive species

Invasive, non-native species are those that arrive in places where they didn't historically live and out-compete local biodiversity for resources. This leads to a shift in the

composition of the natural ecosystem, which can impact ecosystem functions and cause the extinction of native species. There has been a 70% increase in non-native species since 1970, associated with increased trade and human population dynamics and trends. ([IPBES 2019](#))

Philanthropic support for biodiversity

Current funding

While precise data is difficult to obtain and patchy, it is clear that globally, significant resources already flow to support nature conservation, both from public and private sources. According to a recent global survey of 150 philanthropic organizations, for example, a quarter of respondents support the environment and conservation with some portion of their budgets. This is slightly ahead of climate change (23%), but still only the 6th most widely supported cause. ([Rockefeller Philanthropy Advisors 2022](#)) In Germany, ~18% of individual donors reported donating to environmental and conservation NGOs in 2023. ([Deutscher Fundraising Verband 2024](#))

However, the volume share of donations that goes towards the environment and conservation appears to be much smaller. It is estimated to make up only 3.2% of the total amount donated by individuals in Germany. ([Deutscher Spendenrat 2024](#)) Similarly, 3% of all U.S. donations supported the environment/animals in 2023. ([Giving USA 2024](#)) This means that while many individuals and foundations report to support the environment and conservation activities, they appear to do so only with a small share of their philanthropic budget.

Across Europe, foundations spent €1.6 billion on environmental grants in 2021 - including both biodiversity and climate & energy, which are among the largest sub-categories -, according to a recent analysis of 126 foundations. ([Cracknell et al. 2023](#)) The analysis reports strong growth, but also points out that environmental philanthropy “remains a tiny share of total European foundation giving”. Similarly, a recent UK report notes a tripling of environmental giving (again including biodiversity and climate) to just above £600 million by UK foundations between 2018/19 and 2021/22, now accounting for an estimated 8.5% of total UK foundation giving. ([Cracknell et al. 2024](#))

From a different angle, support for nature-based solutions (NbS)¹ from conservation NGOs and philanthropy is estimated at \$3.2 billion globally in 2022. ([UNEP 2023](#)) As the visibility and urgency of the biodiversity crisis has grown, there has been some

¹ Defined as “Actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits”.

momentum in recent years to increase funding for biodiversity conservation, such as through the “[Protecting Our Planet Challenge](#)”, a \$5 billion funding commitment by 11 foundations over a ten year period. That said, it’s still only a tiny fraction of the estimated ~\$800 billion annual philanthropic giving by foundations and individuals globally. ([ClimateWorks 2023](#))

Philanthropic spending is also only a small share of overall funding for NbS. Philanthropic support amounts to ~9% of total private finance flows to NbS of ~\$35 billion, which include funds from biodiversity offsets or carbon markets, for example. And it’s less than 2% of total, i.e. private and public, current finance flows to NbS, which are estimated at \$200 billion. ([UNEP 2023](#))

So in summary, philanthropic giving for biodiversity is a small share of total philanthropic giving, and also only a small share of total finance flows to NbS, which are approximately the size of Greece’s GDP. But even these total flows towards conserving and restoring nature are dwarfed by finance flows with direct negative impacts on nature. As noted above, these flows are estimated to amount to US\$7 trillion in total (~7% of global GDP in 2022), split between \$1.7 trillion in public funding to environmentally harmful subsidies and more than \$5 trillion in private finance flows with a direct negative impact on nature. ([UNEP 2023](#)) In other words, for every \$1 the world spends on conserving and restoring nature, it also invests \$35 that directly harm nature.

Finance needs

The global community has already agreed on different targets to protect and restore nature through the three “Rio Conventions” — on Biodiversity, Climate Change and Desertification — which derive from the 1992 Earth Summit:

- To protect 30% of land and sea by 2030 (30x30 target), as laid out in the [Kunming-Montreal Global Biodiversity Framework](#).
- To limit climate change “to well below 2°C above pre-industrial levels” and pursue efforts “to limit the temperature increase to 1.5°C above pre-industrial levels”, as agreed in the [Paris Agreement](#).
- To reach land degradation neutrality by 2030, as formulated by the [United Nations Convention to Combat Desertification \(UNCCD\)](#)

UNEP estimates that in order to reach all three targets, annual financial flows to NbS from all sources, including philanthropy, need to more than double by 2025, and to almost triple to \$542 billion by 2030, roughly equivalent to Ireland’s GDP today. ([UNEP 2023](#))

Impact focus

In addition to the challenges and opportunities regarding the scale of philanthropic funding for biodiversity, there is little indication that current support is well allocated and focused on maximizing impact, quite similar to [our observations on climate philanthropy](#).

On the positive side, an increasing number of studies and frameworks focus on identifying priorities for conservation and/or restoration. Already in the early 2000s, the concept of Key Biodiversity Areas (KBAs) was developed in a collaborative effort by BirdLife International and the International Union for Conservation of Nature (IUCN), amongst others, with the goal to identify and prioritize sites that contribute significantly to the global persistence of biodiversity. (see e.g., [Eken et al. 2004](#)) In 2016, the first global standard for the identification of KBAs was released. ([IUCN 2016](#)) Today, the IUCN [lists](#) more than 16,000 KBAs that have been mapped worldwide, safeguarding populations of more than 14,000 species of conservation concern. (Less than half are protected, however.) Other frameworks include the [Half-Earth Project Map](#) developed by the E.O. Wilson Biodiversity Foundation, the concept of “[irrecoverable carbon](#)” developed by Conservation International, i.e. stores of carbon in nature that are vulnerable to release from human activity and, if lost, could not be restored by 2050, or the [decision-support tool](#) developed by Senckenberg and the Frankfurt Zoological Society to inform the site selection of the [Legacy Landscape Fund](#), a financial vehicle to guarantee long-term conservation funding for a set of protected areas.

Nonetheless, little guidance is available to donors that would build on these approaches to evaluate interventions to conserve and restore nature based on their cost-effectiveness and recommend the most high-impact organizations that implement them. In addition, in an environment dominated by large, international environmental NGOs such as WWF, Conservation International and The Nature Conservancy, promising smaller organizations in neglected spaces often struggle for funding. This is further aggravated by the fact that the majority of philanthropic support comes in the form of restricted funding for specific projects, further limiting NGOs’ flexibility and often constraining their ability to engage in efforts with the potential to drive systemic change, such as advocacy, for example.

Accordingly, we believe there is an opportunity to review and improve the allocation of existing philanthropic funding to maximize the benefits and impact on ecosystem conservation and restoration. With limited funds from the support of donors interested in this subject area, we have carried out our own shallow analysis of high-impact spaces and charities in this field. These are necessarily less sophisticated and also less detailed than those of [our partners and evaluators](#) in other cause areas. The sections below share some of our findings and beliefs. As an effective giving organization, we would very much welcome more research and the development of robust, evidence-based charity recommendations in this field.

How we think about effective giving for nature

Nature conservation is a popular issue among both individual donors and philanthropic foundations. Total annual giving for biodiversity is significantly higher than for other high-impact but neglected causes such as [global catastrophic risk](#) or [\(farmed\) animal welfare](#). Still, it represents only a small fraction of global giving,

Important policy wins for nature have been achieved in recent years, including through the dedicated efforts of non-profit organizations supported by philanthropic donations. Examples include the 30x30 target of the [Kunming-Montreal Global Biodiversity Framework](#), the [EU Deforestation Regulation](#) or the [EU Nature Restoration Law](#), which was narrowly passed earlier this year, to name but a few. Nonetheless, as shown above, our economic system still largely ignores the benefits and services that biodiversity and functioning ecosystems provide, and it heavily subsidizes environmentally harmful practices.

What the policy successes do point to, however, is the need for systemic change. While nature and biodiversity are inherently local, a project-based approach to conserving and restoring natural ecosystems does not match the challenge humanity faces.

Therefore, we believe that even more important than increased giving is a different approach to effective conservation philanthropy that increases our collective impact. We offer some guiding principles below. Overall, our thinking on high-impact philanthropy to protect and restore biodiversity is guided by our [methodology](#) across cause areas, and key principles to identify promising themes:

- Importance: What's the scale of the problem, or the (sub-)theme? Are a particularly large number of species (or members of a species) significantly affected?
- Tractability: Can we demonstrably solve or improve the situation with additional (philanthropic) funds?
- Neglectedness: Are comparatively few (philanthropic) resources used to address the challenges so far?
- Urgency: Does inaction significantly exacerbate the problem over time? Are we at risk of reaching or crossing irreversible tipping points?

Key considerations

Conservation versus restoration

In identifying philanthropic priorities, we often have to choose between conservation, i.e. the protection of largely undisturbed natural ecosystems, e.g., through protected areas or nature reserves, or restoration, i.e. the effort to restore ecosystems that have already been disturbed and degraded.²

Conservation ranks higher in the mitigation hierarchy as it aims to avoid negative impacts from the outset. In contrast, restoration is often more expensive, it takes years for restored ecosystems to recover, and they typically remain below the levels of biodiversity (and carbon sequestration) of similar, intact ecosystems. (See e.g., [Benayas 2009](#)) This is also reflected in the concept of “irrecoverable carbon”, for example, referring to vulnerable stores of carbon in nature that, if lost, could not be restored by 2050. (See [Noon 2022](#))

This is particularly relevant for the loss of individual species. As already described above, we are in what many scientists have declared the sixth mass extinction. (See [Ceballos et al. 2015](#) or [Ceballos and Ehrlich 2023](#)) Once a species is extinct, it cannot be brought back and restoration is no longer a solution.

However, the effectiveness of conservation hinges crucially on identifying areas at risk of being converted or degraded, particularly for agricultural purposes. The impact of conservation can be defined as the difference between the preserved state of the ecosystem and the state of the land in expectation without any conservation efforts. In other words, a conservation project only creates impact if the preserved ecosystem would have otherwise been converted or degraded, a counterfactual that’s often hard to establish. Conversely, investing in conserving activities in an area that’s not at risk creates zero counterfactual impact.

Nonetheless, on balance, we believe that (cost-effective) conservation opportunities should be somewhat prioritized over restoration, although both will be needed to reach the goal of setting aside roughly half of Earth’s land and seas for nature, which scientists consider necessary to halt the dual crises of biodiversity loss and climate change. ([Dinerstein et al. 2020](#))

² IPBES 2021 also identifies the management of human-dominated landscapes, the creation of new ‘scapes’, ecosystem-based adaptation, and transforming human behaviors as additional solutions, but we prioritized the primary two in our analysis of how to most effectively contribute to halting the conversion and degradation of nature.

Nature, climate and socio-economic co-benefits

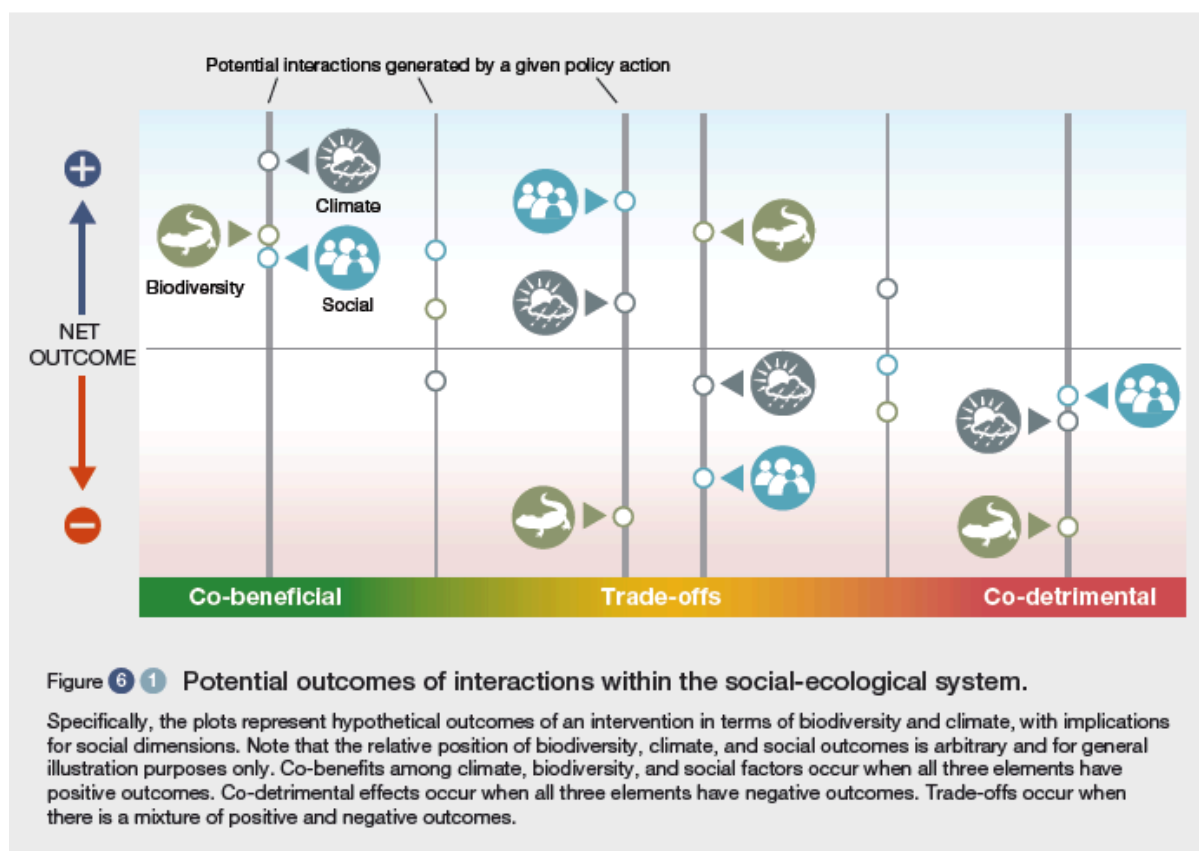
Forest restoration projects have been an important part of the ([often criticized](#)) voluntary carbon markets. These projects have been dominated by monoculture plantations, which — while storing some amount of carbon — do very little to support or may even harm local biodiversity. Depending on their setup, the economic benefits to local communities are also often unclear.

Similarly, fisheries subsidies to support distant-water fishing in response to declining fish stocks could further increase overfishing and contribute to additional GHG emissions from the fishing industry. And while providing short-term socio-economic benefits to affected fishermen, the additional pressure on fish stocks is likely to only exacerbate the economic pressure on the industry, affecting small-scale and artisanal fishermen in particular, and leading to negative biodiversity, climate and social impacts.

These are just two examples of the challenges that are often involved in achieving climate, biodiversity, and social objectives. In the best case, efforts are co-beneficial, i.e. create benefits across all three dimensions, such as when high-carbon, biodiversity-rich ecosystems are restored in such a way that they provide livelihood opportunities for local communities. But quite often, they involve trade-offs or can even be "co-detrimental", as schematically shown in Figure 6.

Figure 6 – Biodiversity-Climate-Social interactions

(Figure 6.1 in [IPBES 2021](#))



We therefore need to prioritize efforts and approaches that are "co-beneficial" and create "win-win-win" (or at least "win-win-neutral") situations for the climate, biodiversity and socio-economic development for two main reasons:

1. With scarce (philanthropic) resources, we should focus on those areas and interventions first that provide a broad set of benefits, rather than accepting trade-offs.
2. "Co-beneficial" solutions have a higher chance of success. Solutions that do not adequately integrate social considerations in particular are likely to fail if they go against the needs and interests of the local population.

In addition, the highly dynamic nature of climate change and the progressive loss of biodiversity require far-sighted thinking and a radical focus. Many ecosystems are already impacted even at current levels of global warming, and many more will experience shifts and changes in the future as temperatures increase further. Under a +2 °C warming scenario, half of global land area will experience climate conditions that correspond with different ecoregions and nearly a quarter will experience climates from a different biome. ([Dobrowski et al. 2021](#)) Accordingly, ecoregions that cannot withstand such dramatic changes in conditions are unlikely to be suitable targets for conservation or restoration efforts.

Which types of ecosystems should be prioritized?

The importance of forests — and (sub-)tropical rainforests such as the Amazon in particular — is often highlighted in public discourse, both for the climate and as havens of biodiversity. Tropical forests encompass less than one-fifth of Earth's terrestrial area, but support more than half of the world's species ([Dinerstein et al. 2017](#)). Their protection provides significant potential for climate mitigation. (See Figure 7 below.) Through the [REDD+ framework](#), forests are even singled out as an element under the UN Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. Yet, because of the attention forests already receive from policymakers, businesses, the public, and philanthropists, they appear less neglected in comparison with other types of ecosystems, which makes it somewhat harder and less likely to identify additional high-impact funding opportunities.

In our analysis, inland and coastal wetlands stand out as particularly promising. (See Figure 7.) Although they only cover ~2% of the earth ([Davidson et al. 2018](#)), they are home to 40% of the world's biodiversity. ([Ramsar 2021a](#)) Over a million endangered plant and animal species depend on wetlands for their survival. Wetlands are among the largest stores of carbon on earth: they store more than 20% of global organic ecosystem carbon. ([Temmink et al. 2022](#)) Global peatlands alone store up double the amount of CO₂ as all tropical rainforests — but at two to four times the density per area. In addition, coastal ecosystems provide valuable ecosystem services, both for the incomes of the local population as well as in the form of natural protection against

storms and floods. More than a billion people worldwide depend on them for their livelihoods. ([UN 2023](#)) Yet, despite their importance, they receive far less attention.

Figure 7 – Impact potential and speed of different types of ecosystems

	Conserve			Restore		
	GHG abatement Gt CO ₂ e p.a. by 2030	Biodiversity impact	Time to impact	GHG abatement Gt CO ₂ e p.a. by 2030	Biodiversity impact	Time to impact
Forests	2.6	high	fast	1.0	high	medium
Wetlands	1.0	high	fast	1.0	high	slow
Savannah, grassland	0.6	medium	fast	tbd	tbd	tbd
Coastal ecosystems	0.4	high	fast	0.3	medium	medium

■ = identified priorities

As shown above, oceans also play a tremendously important role for the stability of our planet, as a buffer against climate change, and for global biodiversity. Yet, they are also much less in the focus of the global debate or conservation philanthropy. Accordingly, it is likely that they also provide high-impact philanthropic opportunities. Due to limited time and resources, we did not have the capacity to investigate this area beyond coastal wetlands, and we would welcome more research and guidance in this area.

How to multiply your impact

Similar to our approach for [identifying opportunities for high-impact climate action](#), “impact multipliers” can generate outsized impacts.

While the protection and restoration of biodiversity and functioning ecosystems is inherently local, the size of the challenge is too big to be addressed by local action alone. We will not succeed if we invest scarce philanthropic resources to tackle the biodiversity crisis project by project. Instead (or in addition), we need to identify levers that create systemic change, e.g., by changing the policy environment or affecting market dynamics. If successful, such efforts shift public resources and affect private sector spending, both of which are by magnitudes larger than philanthropic resources alone.

Recent examples of such efforts include the “30x30 campaign”, for example, which – supported with significant philanthropic resources – contributed to the adoption of the

“30x30” target³ of the [Kunming-Montreal Global Biodiversity Framework](#) (GBF) in 2022. Civil society organizations also played an important role in ensuring that [wetlands were explicitly recognized](#) in the GBF (as “inland waters and coastal ecosystems”).

In Europe, civil society actors advocated strongly for the adoption of the EU Deforestation Regulation and the EU Nature Restoration Law, contributing to enhanced nature protection and restoration in Europe and increased scrutiny on European commodity supply chains.

Four promising fields that we have identified

Based on the above analysis and considerations, we have identified a number of opportunities that we believe are particularly promising at the intersection of climate and nature. As noted above, these are based on our cursory review and are neither conclusive nor exhaustive. We strongly encourage more comprehensive efforts to guide high-impact philanthropy in this area.

Alternative proteins

As demonstrated above, animal agriculture is the predominant reason for agriculture’s large land-use footprint, and a strong driver of the continued conversion of nature. Beef and lamb, in particular, require orders of magnitude more land than crops on a calorie-for-calorie basis. Producing the same number of calories from beef as from peas (a base ingredient in alternative proteins) requires more than 50 times as much land. ([Ritchie et al. 2022](#)). Every calorie of beef we eat needs 100 calories of feed as input, thus requiring large areas of cropland to grow animal feed in addition to the land needed for cattle grazing. ([Searchinger al. 2019](#)) A chicken, which converts feed into edible meat more efficiently than most farmed animals, still needs nine calories of feed to produce one calorie of meat.

Replacing meat in people’s diets — particularly beef and lamb — could therefore drastically reduce the demand for agricultural land. If the world were to switch to an entirely plant-based diet, food’s land use would be reduced by 76%, an area roughly equivalent to the entire landmass of Africa. ([Poore and Nemecek 2018](#)). Unfortunately, it is unrealistic to expect large segments of the population to give up meat and other animal products. While meat consumption in Germany [is declining](#), this is the exception, and global meat production [continues to rise](#).

Alternative proteins — plant-based meat, cultivated meat, or fermentation-based products — are a potential substitute for animal-based meat without the need for the challenging behavior change of giving up meat entirely. Their environmental footprint is

³ GBF Target 3: “Ensure and enable that by 2030 at least 30 per cent of terrestrial and inland water areas, and of marine and coastal areas, especially areas of particular importance for biodiversity and ecosystem functions and services, are effectively conserved and managed [...]”

[substantially lower](#) than that of animal-based products, e.g., reducing GHGs and land use by up to ~95% compared to beef. They are the equivalent to wind and solar PV in electricity production, or to electric vehicles in transportation: a scalable, technical solution for the decarbonization of meat production. Even a modest diversification of protein sources would have a significant impact: if a sixth of meat and dairy is displaced by alternative proteins, 21% of domestic farmland and 9% of the land overseas used for imports would be freed up, according to a recent analysis of 10 European countries. ([Collas and Benton 2024](#))

Yet, despite the increasing recognition of alternative proteins as a potential solution, they are still leading a niche existence. From a consumer perspective, alternative proteins are still more expensive and mostly not yet equivalent in taste to their animal products. From an investment perspective, cumulative all-time investment in alternative proteins still only amounts to ~\$16 billion, ([The Good Food Institute 2023](#)) compared to annual investments of \$1.9 trillion in clean energy in 2023. ([IEA 2024](#)) Global public spending on research and development, deployment, and commercialization needs to increase to around \$10 billion per year to unlock the full benefits of alternative proteins. ([ClimateWorks & UK Foreign, Commonwealth, and Development Office 2021](#))

Our [top recommendation The Good Food Institute](#) (GFI) promotes the development of sustainable alternatives to conventional meat, working towards “a world where alternative proteins are no longer alternative.” GFI advocates for public funding and lays the foundation for the sector’s further development by funding open access research. As a think tank, GFI supports scientists, politicians and companies to accelerate the development and diffusion of competitive alternatives.

By increasing R&D on cultivated meat, promoting the commercialization of plant-based meats, and advocating for a policy environment that is conducive to the development of alternative proteins overall, philanthropic giving can accelerate improvements in taste and price, and thus the widespread adoption of these foods, where the land and environmental benefits are realized. In addition, the suffering of farmed animals will be reduced, as the need for meat from animals intensively raised in industrialized environments declines.⁴

Supply chain transparency

In 2023, the world lost 3.7 million hectares of tropical forest. ([WRI 2024](#)) At least 90% of all deforestation in the tropics is driven either directly or indirectly by agriculture. ([Pendrill et al. 2022](#)) The commodities beef, soy, pulp and paper, cocoa, and palm oil in particular are drivers of deforestation.

⁴ Our recent Climate Change Giving Fund [grant to Food Frontier](#) follows the same theory of change.

Almost one-third (29%) of deforestation in the tropics is caused by international trade. ([Ritchie 2021c](#)) Hence, it provides an important opportunity to reduce deforestation through global consumers and supply chains.

[Global Canopy](#), a UK-based data-driven non-profit, targets this area with a focus on transparency and accountability in global commodity markets to halt and reverse global deforestation. The organization works across three primary areas:

1. Supply chain transparency: mapping the trade and financing of commodities linked to deforestation;
2. Nature-related finance, developing high-quality data to tackle nature-related risks and opportunities; and
3. Corporate Performance, providing market-leading data on the policies and performance of influential companies and financial institutions.

Global Canopy has (co-)developed and launched a number of tools and platforms, e.g., [Trase](#), the “world’s most comprehensive open-access database” on forest risk commodities (including beef, soy, pulp and paper, palm oil, and cocoa), and [ENCORE](#), a free online tool which helps organizations explore their exposure to nature-related risk. The tool has already been used by financial institutions including Banque de France, Swiss Re, the World Bank, and De Nederlandsche Bank (DNB), and central banks including Banco de Mexico. Global Canopy is also a founding partner of the [Taskforce on Nature-related Financial Disclosures](#) (TNFD), alongside UNDP, UNEP FI and WWF.

Through its tools, the organization supports - and confronts - companies, financial institutions, media, governments and NGOs with data, metrics and insights on the impacts of commodities on nature and climate, and on the (often underestimated) risk exposure of the economy’s dependence on natural ecosystems. In addition, it promotes the improvement of regulation and company policies to identify, account for and avoid nature risks and damages.

The law

As shown above, more than half of global GDP is dependent on nature and its services. ([WEF 2020](#)) However, these enormous, positive “external effects” of nature are largely consumed free of charge by our global economy. (And, ultimately, by us as consumers.) On the other hand, companies invest trillions in activities that have a direct negative impact on nature, and are depleting natural capital as a result. ([UNEP 2023](#))

Our regulatory and economic systems are thus still insufficient to steer our economy into a direction that protects nature’s services and that is compatible with the goals of frameworks such as the Paris Climate Agreement or the Kunming-Montreal Global Biodiversity Framework, amongst others.

The law offers a promising approach to changing this: once something becomes law, [it can be enforced](#). Strategic litigation can trigger significant change for entire industries, regions, or countries.

[ClientEarth](#) uses the law to fight climate change and environmental degradation. Through legal action, strategic communications and advocacy, the organization's lawyers and environmental experts work around the world to ensure that existing environmental laws are upheld and that effective climate and environmental policies are designed and implemented.

Wherever possible, ClientEarth focuses on areas that open up the legal space for subsequent efforts by other organizations. Thus, in addition to its direct impact, ClientEarth also acts as an innovator and trailblazer for legal action pursued by other organizations.

ClientEarth works across the full cycle of the law, ranging from advising policy-makers and pushing for legal reforms to supporting the successful implementation and enforcement of laws to holding governments and companies to account through legal actions. Some highlights of their work to protect nature that demonstrate the role that the law can play in contributing to change include:

- [Training more than 1,500 judges in China](#) on environmental rule of the law, equipping them with learning and case studies on European and UK environmental adjudication practices, as well an understanding of the science and theory which underpins environmental litigation.
- Stepping in to save [Bialowieza Forest](#), one of Europe's oldest and last primeval forests, by challenging the Polish government in court and supporting the international legal battle for its preservation at the EU Court of Justice.
- Engaging in international negotiations treaties, such as the Paris Agreement and the [Global Biodiversity Framework](#).
- Tackling [overfishing](#) in the EU.

Wetlands

As shown above, wetlands provide enormous value as havens of biodiversity, for carbon storage, and to support livelihoods. Yet, they are among the most threatened ecosystems in the world. (See e.g., [Asselen et al. 2013](#)) Recent analysis suggests that 3.4 million square kilometers of natural inland wetlands (or 21% of the global total) have been lost since 1700, an area larger than India. Across many regions, including the United States, Europe, Central Asia, India, China, and Southeast Asia, over 50% of wetlands were lost. ([Fluet-Chouinard et al. 2023](#)) Other analyses present even higher figures of loss, from more than 50% up to 85% of all wetlands since 1700. ([Davidson 2014](#)) According to the Global Wetlands Outlook by the Convention on Wetlands, 35% of natural wetlands have been lost since 1970 alone. ([Ramsar 2021b](#)) That's three times faster than the rate

of deforestation, with significant impacts on local biodiversity: Since 1970, the populations of 81% of inland wetland species and 36% of coastal and marine species have declined. CO2 emissions from drained peatlands and peatland fires equate to 10% of annual fossil fuel emissions. ([Ramsar 2021c](#))

Accordingly, the conservation and restoration of wetlands are urgent, and experts agree that philanthropic engagement can play an important role. As the only global organization with an exclusive focus on wetlands, [Wetlands International](#) aims to draw attention to the critical issues facing wetlands, as well as the levers for change (“Inspire”); to create the conditions for the scaling of proven solutions through pilot projects and coalitions (“Mobilize”); and to achieve comprehensive change through strategic alliances and partnerships and by influencing the policy framework (“Upscale”). ([Wetlands International 2020](#))

In addition to project work on the ground, the organization works to drive systemic change across different approaches:

- Policy and campaigns: Wetlands International mobilizes governments and businesses through targeted campaigns that build on the organization’s deep technical knowledge, experience in policy dialogue and numerous projects on the ground.
- Coalitions: The organization systematically invests in building powerful coalitions of governments, civil society and the private sector, e.g. the [Global Mangrove Alliance](#) and the [Global Peatlands Initiative](#).
- Technology platforms and data: Wetlands International is, among others, co-initiator of [Global Mangrove Watch](#), an online platform that provides near real-time monitoring and alerts.
- Institution & know-how building: Multidisciplinary teams and expert networks provide evidence-based and technical advice to governments, wetland authorities and civil society.

Through its efforts, the organization was able to contribute, for example, to the explicit mention of wetlands “inland water, and coastal [...] ecosystems” in the [Kunming-Montreal Global Biodiversity Framework](#). Its “[Building with Nature Indonesia](#)” initiative was selected as one of ten [flagship initiatives](#) under the UN Decade of Ecosystem Restoration, illustrating the scale and potential of the restoration work already underway.

References

- Armstrong McKay, D. et al. (2022), “Exceeding 1.5°C global warming could trigger multiple climate tipping points”, *Science* 377, eabn 7950.
<https://doi.org/10.1126/science.abn7950>
- Asselen, S.v. et al. (2013), “Drivers of Wetland Conversion: a Global Meta-Analysis”, *PLOS ONE* 8(11): e81292. <https://doi.org/10.1371/journal.pone.0081292>
- Basso, L. S. et al. (2023), “Atmospheric CO₂ inversion reveals the Amazon as a minor carbon source caused by fire emissions, with forest uptake offsetting about half of these emissions”, *Atmospheric Chemistry and Physics*, 23(17), 9685–9723.
<https://doi.org/10.5194/acp-239685-2023>
- Benayas, J. M. R. et al. (2009), “Enhancement of Biodiversity and Ecosystem Services by Ecological Restoration: A Meta-Analysis.” *Science* 325, no. 5944: 1121–24.
<https://doi.org/10.1126/science.1172460>
- Capaldi, C.A. et al. (2014), “The relationship between nature connectedness and happiness: a meta-analysis”, *Front. Psychol.*, 08 September 2014, Sec. Cognitive Science, Volume 5 - 2014, <https://doi.org/10.3389/fpsyg.2014.00976>
- Ceballos, G. et al. (2015), “Accelerated Modern Human-Induced Species Losses: Entering the Sixth Mass Extinction.” *Science Advances* 1, no. 5: e1400253.
<https://doi.org/10.1126/sciadv.1400253>
- Ceballos, G. & Ehrlich, Paul R. (2023) “Mutilation of the tree of life via mass extinction of animal genera” *Proceedings of the National Academy of Sciences, USA*, 120:e2306987120. <https://www.pnas.org/doi/abs/10.1073/pnas.2306987120>
- Chatterjee et al. (2022), “Indigenous People and Nature”, *Science Direct*.
<https://www.sciencedirect.com/book/9780323916035/indigenous-people-and-nature>
- Chislock, M. F. et al. (2013), “Eutrophication: Causes, Consequences, and Controls in Aquatic Ecosystems”, *Nature Education Knowledge* 4(4):10.
<https://www.nature.com/scitable/knowledge/library/eutrophication-causes-consequences-and-controls-in-aquatic-102364466/> (accessed on 21 October 2024)
- ClimateWorks Foundation & UK Foreign, Commonwealth, and Development Office (2021), “Global Innovation Needs Assessment: Protein Diversity”.
<https://www.climateworks.org/wp-content/uploads/2021/11/GINAs-Protein-Diversity.pdf>
- ClimateWorks Foundation (2023), “Funding trends 2023: Climate change mitigation philanthropy”. <https://www.climateworks.org/report/funding-trends-2023/>
- Collas, L. and Benton, D. (2024), “A new land dividend: the opportunity of alternative proteins in Europe”, *Green Alliance*.
<https://green-alliance.org.uk/publication/a-new-land-dividend-the-opportunity-of-alternative-proteins-in-europe/> (accessed on 20 October 2024)
- Cracknell, J. et al. (2023), “Environmental Funding by European Foundations — Volume 6”, *Philea - Philanthropy Europe Association*.
<https://philea.issuelab.org/resource/environmental-funding-by-european-foundations-volume-6.html>

- Cracknell, J. et al. (2024), “Where the Green Grants Went - 9 Patterns of UK Funding for Environmental Work”. Environmental Funders Network.
<https://www.greenfunders.org/wp-content/uploads/WTGGW9-FINAL1.pdf> (accessed on 20 October 2024)
- Dasgupta, P. (2021), “The Economics of Biodiversity: The Dasgupta Review”, London: HM Treasury.
<https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review> (accessed on 20 October 2024)
- Davidson N. C. (2014) “How much wetland has the world lost? Long-term and recent trends in global wetland area.”, *Marine and Freshwater Research* 65, 934-941.
<https://doi.org/10.1071/MF14173>
- Davidson N. C., et al. (2018), “Global extent and distribution of wetlands: trends and issues”, *Marine and Freshwater Research* 69, 620-627.
<https://doi.org/10.1071/MF17019>
- Deutscher Fundraisingverband (2024), “Deutscher Spendenmonitor 2023”.
<https://www.dfrv.de/spendenmonitor-2023/> (accessed on 16 July 2024)
- Deutscher Spendenrat (2024), “Bilanz des Helfens 2023”.
<https://www.spendenrat.de/wp-content/uploads/Downloads/Bilanz-des-Helfens/bilanz-des-helfens-2023-deutscher-spendenrat.pdf>
- Dinerstein E. et al. (2017), “An ecoregion-based approach to protecting half the terrestrial realm”, *BioScience* 67: 534–45. <https://doi.org/10.1093/biosci/bix014>
- Dinerstein, E. et al. (2020), “A “Global Safety Net” to reverse biodiversity loss and stabilize Earth’s climate”, *Sci. Adv.* 6, eabb2824. <https://doi.org/10.1126/sciadv.abb2824>
- Dobrowski, S.Z. et al. (2021), “Protected-area targets could be undermined by climate change-driven shifts in ecoregions and biomes”, *Commun Earth Environ* 2, 198.
<https://doi.org/10.1038/s43247-021-00270-z>
- Eken, G. et al. (2004), “Key Biodiversity Areas as Site Conservation Targets”, *BioScience*, Volume 54, Issue 12, December 2004, Pages 1110–1118,
[https://doi.org/10.1641/0006-3568\(2004\)054\[1110:KBAASC\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2004)054[1110:KBAASC]2.0.CO;2)
- Flores, B. M. et al. (2024), “Critical transitions in the Amazon forest system”, *Nature*, 626, 555-564. <https://doi.org/10.1038/s41586-023-06970-0>
- Fluet-Chouinard, E. et al. (2023), “Extensive global wetland loss over the past three centuries”, *Nature* 614, 281–286. <https://doi.org/10.1038/s41586-022-05572-6>
- Food and Agriculture Organization of the United Nations FAO (2024), “The State of World Fisheries and Aquaculture 2024 – Blue Transformation in action”. Rome.
<https://doi.org/10.4060/cd0683en>
- Friedlingstein, P. et al. (2023), “Global Carbon Budget 2023”, *Earth Syst. Sci. Data*, 15, 5301–5369. <https://doi.org/10.5194/essd-15-5301-2023>
- Gatti, L.V. et al. (2021), “Amazonia as a carbon source linked to deforestation and climate change”, *Nature* 595, 388–393. <https://doi.org/10.1038/s41586-021-03629-6>
- Giving USA (2024), “U.S. charitable giving totaled \$557.16 billion in 2023”, 25 June 2024.
<https://givingusa.org/giving-usa-u-s-charitable-giving-totaled-557-16-billion-in-2023> (accessed on 16 July 2024)

- Hamim, H. et al. (2023). "Islam and Stewardship", in: Values in Sustainable Development, Routledge.
https://www.researchgate.net/publication/370444934_Islam_and_Stewardship
- Harris, N.L. et al. (2021), "Global maps of twenty-first century forest carbon fluxes", Nat. Clim. Chang. 11, 234–240. <https://doi.org/10.1038/s41558-020-00976-6>
- Intergovernmental Panel on Climate Change IPCC (2018), Summary for Policymakers. In: "Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.". <https://doi.org/10.1017/9781009157940.001>
- IPCC (2022), Summary for Policymakers In: "Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change", Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-33.
<https://doi.org/10.1017/9781009325844.001>
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services IPBES (2019), "Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services." IPBES secretariat, Bonn, Germany.
<https://doi.org/10.5281/zenodo.3553579>
- IPBES (2021), "Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change", IPBES secretariat, Bonn, Germany,
<https://doi.org/10.5281/zenodo.4659158>
- International Energy Agency IEA (2024), "World Energy Investment 2024".
<https://www.iea.org/reports/world-energy-investment-2024> (accessed on 17 October 2024)
- International Union for Conservation of Nature IUCN (2016), "A Global Standard for the Identification of Key Biodiversity Areas", Version 1.0, Gland, Switzerland, IUCN.
<https://portals.iucn.org/library/node/46259>
- IUCN (2024), "IUCN Red List", Summary Statistics,
<https://www.iucnredlist.org/resources/summary-statistics> (accessed on 16 July 2024)
- Keaulana, S. et al. (2021), "A Scoping Review of Nature, Land, and Environmental Connectedness and Relatedness", International Journal of Environmental Research and Public Health 18, no. 11: 5897. <https://doi.org/10.3390/ijerph18115897>
- Klein Goldewijk, K., et al. (2017), "Anthropogenic land use estimates for the Holocene", Earth System Science Data 9, no. 2, 1 December 2017, 927–53.
<https://doi.org/10.5194/essd-9-927-2017>
- Lovejoy, T.E. and Nobre, C. (2019), "Amazon tipping point: Last chance for action", Sci. Adv. 5, eaba 2949. <https://doi.org/10.1126/sciadv.aba2949>
- Martin, L. et al. (2020), "Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours", Journal of Environmental

- Psychology, Volume 68, 101389, ISSN 0272-4944,
<https://doi.org/10.1016/j.jenvp.2020.101389>
- OECD (2022), “Global Plastics Outlook: Economic Drivers, Environmental Impacts and Policy Options”, 22 February 2022. <https://doi.org/10.1787/de747aef-en>
- Noon, M.L. et al. (2022), “Mapping the irrecoverable carbon in Earth’s ecosystems”, *Nat Sustain* 5, 37–46. <https://doi.org/10.1038/s41893-021-00803-6>
- Pendrill, F.R. et al. (2022) “Disentangling the numbers behind agriculture-driven tropical deforestation”, *Science* 377, eabm 9267. <https://doi.org/10.1126/science.abm9267>
- Poertner, H.O. et al. (2021), “Scientific outcome of the IPBES-IPCC co-sponsored workshop on biodiversity and climate change”, IPBES secretariat, Bonn, Germany.
<https://doi.org/10.5281/zenodo.4659158>
- Poore, J., and T. Nemecek (2018), “Reducing Food’s Environmental Impacts through Producers and Consumers.” *Science* 360, no. 6392 (June 2018): 987–92.
<https://doi.org/10.1126/science.aag0216>
- Pope Francis (2015), “Laudato si’”, Encyclical Letter, 24 May 2015.
https://www.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html
- Pritchard, A., et al. (2020), “The Relationship Between Nature Connectedness and Eudaimonic Well-Being: A Meta-analysis”. *J Happiness Stud* 21, 1145–1167.
<https://doi.org/10.1007/s10902-019-00118-6>
- Ramsar Convention on Wetlands Secretariat (2021a), “Factsheet: Wetlands and Biodiversity”.
https://www.ramsar.org/sites/default/files/ramsar_50_factsheet_biodiversity_english_as_v7.pdf (accessed on 30 September 2024)
- Ramsar Convention on Wetlands Secretariat (2021b), “Global Wetland Outlook: Special Edition 2021”, Switzerland: Secretariat of the Convention on Wetlands.
<https://www.global-wetland-outlook.ramsar.org/report-1> (accessed on 8 October 2024)
- Ramsar Convention on Wetlands Secretariat (2021c), “Restoring drained peatlands: now an environmental imperative”.
https://www.ramsar.org/sites/default/files/documents/library/factsheet_wetland_restoration_peatlands_e.pdf (accessed on 14 October 2024)
- Richardson, K. et al. (2023), “Earth beyond six of nine planetary boundaries”, *Sci. Adv.* 9, eadh2458. <https://doi.org/10.1126/sciadv.adh2458>
- Ritchie, H. (2021a), “Wild mammals have declined by 85% since the rise of humans, but there is a possible future where they flourish”, *Our World in Data*, April 2021.
<https://ourworldindata.org/wild-mammal-decline> (accessed on 8 October 2024)
- Ritchie, H. (2021b), “Excess fertilizer use: which countries cause environmental damage by overapplying fertilizers?”, *Our World in Data*, 7 September 2021.
<https://ourworldindata.org/excess-fertilizer> (accessed on 7 August 2024)
- Ritchie, H. (2021c), “Deforestation and Forest Loss”, *Our World in Data*, February 2021.
<https://ourworldindata.org/deforestation#one-third-of-co2-emissions-from-deforestation-are-embedded-in-international-trade> (accessed on 8 October 2024)

- Ritchie, H. (2022), “Wild mammals make up only a few percent of the world’s mammals”, Our World in Data, December 2022.
<https://ourworldindata.org/wild-mammals-birds-biomass> (accessed on 7 August 2024)
- Ritchie, H. et al. (2022), “Environmental Impacts of Food Production”, Our World in Data.
<https://ourworldindata.org/environmental-impacts-of-food> (accessed on 2 October 2024)
- Ritchie, H. & Roser, M. (2024), “Half of the world’s habitable land is used for agriculture”, Our World in Data, 16 February 2024.
<https://ourworldindata.org/global-land-for-agriculture> (accessed on 7 August 2024)
- Rockefeller Philanthropy Advisors (2022), “Global Trends and Strategic Time Horizons in Philanthropy 2022”, New York, USA.
<https://www.rockpa.org/wp-content/uploads/2022/07/Time-Horizons-2022-1.pdf>
- Searchinger, T. et al. (2018), “Creating a Sustainable Food Future”, World Resources Institute (WRI).
https://research.wri.org/sites/default/files/2019-07/WRR_Food_Full_Report_0.pdf
- Souter, D. et al. (eds) (2021), “Status of coral reefs of the world: 2020 report”, Global Coral Reef Monitoring Network (GCRMN) and International Coral Reef Initiative (ICRI).
<https://doi.org/10.59387/WOTJ9184>
- Toensmeier, E. et al. (2020), “Farming our way out of the climate crisis”, Project Drawdown.
https://drawdown.org/sites/default/files/pdfs/DrawdownPrimer_FoodAgLandUse_Dec2020_01c.pdf
- Taylor, C. A., and Rising, J. (2021) “Tipping Point Dynamics in Global Land Use.” Environmental Research Letters 16, no. 12, 1 December 2021, 125012.
<https://doi.org/10.1088/1748-9326/ac3c6d>
- Temmink, R. J. M. et al. (2022), “Recovering wetland biogeomorphic feedbacks to restore the world’s biotic carbon hotspots”, Science 376, eabn1479.
<https://doi.org/10.1126/science.abn1479>
- The Good Food Institute (2024), State of the Industry Report series: “Cultivated meat and seafood”, “Plant-based meat, seafood, eggs, and dairy”, “Fermentation: Meat, seafood, eggs, and dairy”. <https://gfi.org/state-of-the-industry-reports/> (accessed on 8 October 2024)
- United Nations (2023), “Revive and restore wetlands, home to 40 per cent of all biodiversity”, UN News. <https://news.un.org/en/story/2023/02/1133072> (accessed on 30 September 2024)
- United Nations Environment Programme UNEP (2017), “Indigenous people and nature: a tradition of conservation”, 26 April 2017.
<https://www.unep.org/news-and-stories/story/indigenous-people-and-nature-tradition-on-conservation> (accessed on 16 July 2024)
- UNEP (2023), “State of Finance for Nature 2023”, 09 December 2023.
<https://www.unep.org/resources/state-finance-nature-2023>
- UNEP (2024), “Global Resources Outlook 2024”, 01 March 2024.
<https://www.unep.org/resources/Global-Resource-Outlook-2024>

- von Schuckmann, K. et al. (2023) “Heat stored in the Earth system 1960–2020: where does the energy go?”, *Earth Syst. Sci. Data*, 15, 1675–1709, 2023.
<https://doi.org/10.5194/essd-15-1675-2023>
- Wetlands International (2020), “Strategic Intent 2020-2030”.
<https://www.wetlands.org/strategic-intent-2020-2030/> (accessed on 8 October 2024)
- Will, S. et al. (2015), “Planetary boundaries: Guiding human development on a changing planet”, *Science* 347, 1259855. <https://doi.org/10.1126/science.1259855>
- Williams, D. R. et al. (2020), “Proactive Conservation to Prevent Habitat Losses to Agricultural Expansion.” *Nature Sustainability* 4, no. 4, 21 December 2020, 314–22.
<https://doi.org/10.1038/s41893-020-00656-5>
- World Economic Forum WEF (2020), “Nature Risk Rising: Why the Crisis Engulfing Nature Matters for Business and the Economy”, Geneva, Switzerland, 19 January 2020.
https://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf
- WEF (2024), “Global Risks Report 2024”, Geneva, Switzerland, 10 January 2024.
<https://www.weforum.org/publications/global-risks-report-2024/>
- World Health Organization (2022), “Dietary and inhalation exposure to nano- and microplastic particles and potential implications for human health”.
<https://www.who.int/publications/i/item/9789240054608>
- World Resources Institute (WRI) Global Forest Review (2024), “Forest Pulse: The Latest on the World’s Forests”, 4 April 2024.
<https://research.wri.org/gfr/latest-analysis-deforestation-trends> (accessed on 6 August 2024)
- WWF (2024), “Living Planet Report 2024 - A System in Peril”, Gland, Switzerland.
<https://livingplanet.panda.org/> (accessed on 10 October 2024)
- Zolotova, N. et al. (2022), “Harmful effects of the microplastic pollution on animal health: a literature review”, *PeerJ*. 2022 Jun 14;10:e13503.
<https://doi.org/10.7717/peerj.13503>