Net positive: why biodiversity metrics make for more effective carbon markets

ZURICH

Executive Summary

A globally agreed indicator of the impacts of carbon projects on natural ecosystems could transform the voluntary carbon market to drive positive change for biodiversity, as well as for climate change. Zurich is calling for governments, businesses, scientists, and NGOs to step up collaboration on fast-tracking the development of such an indicator.

Natural climate solutions

In addition to the important steps being taken to decarbonize our economics, there is growing recognition of the potential to support climate change mitigation efforts by conserving and rehabilitating natural ecosystems. Many terrestrial and marine ecosystems – from forests to peatlands, mangroves and oceans – are natural carbon sinks. By some estimates, the optimal deployment of nature-based solutions could provide up to 37% of the reduction in CO2 required by 2030 to keep global temperature increases under the 2°C target.

Healthy ecosystems offer a range of other benefits alongside climate change mitigation. These include strengthening capacity to adapt to climate change, as natural ecosystems tend to be more resilient to shocks such as extreme weather events; enhancing food security, which relies heavily on biodiversity; and boosting economic growth, from creating jobs to providing "ecosystem services" such as improved air quality and clean water.

Because of these additional impacts, natural climate solutions that protect ecosystems can deliver broad benefits to society and the economy. However, some poorly designed carbon projects – such as planting monocultures of fast-growing commercial timber species – can undermine the health of ecosystems, compromising their wider benefits and ultimately also undermining their capacity to absorb carbon.

The voluntary carbon market

The voluntary carbon market is growing rapidly: by some estimates it could increase by a factor of 15 by 2030. And within this market, demand for high quality carbon credits generated from nature is also growing.

However, high quality, well-designed nature-based projects that do a good job of protecting biodiversity tend to be more expensive than those which focus narrowly on short-term carbon impacts. For example, growing a healthy forest that contains a variety of tree species is more complex than simply planting a monoculture. If investors are to justify the additional cost of quality carbon projects that enhance biodiversity, they need to be able to credibly demonstrate the additional impact.

The voluntary carbon market is moving towards greater transparency on the impacts of projects – including their wider impacts on nature and local communities, as well as on carbon. But there remains a need for a metric that can allow for direct comparison of projects to support buyers in selecting higher quality carbon credits, and potentially also be integrated into reporting and disclosure frameworks.

Towards a single metric

Developing a single metric to characterize biodiversity is a challenge. There is no shortage of environmental data – what is lacking is a unified approach to harnessing that data into a holistic quantification of biodiversity and how it is changing over time. The value of ecosystems lies in their overall web of interactions, but current metrics tend to focus on narrow aspects of diversity – such as the number of species – which give only a limited picture.

New approaches are being developed that offer the potential to monitor ecosystems more holistically, by combining technologies such as satellite imagery, genetic analysis, digital systems and machine learning. The SEED Biocomplexity Index being led by Crowther Lab at ETH Zurich is one leading example.

Introduction

Nature contributes substantially to climate change mitigation by absorbing and storing vast stocks of carbon. Biodiversity – the complex web of flora, fauna, and habitat – determines not only the resilience of our food systems and the quality of our air and water, but also, increasingly, our capacity to mitigate and adapt to the effects of climate change.

The voluntary carbon market has the potential to play a major role in harnessing nature to meet net-zero targets, while also putting vital funding into the hands of Indigenous Peoples and local communities, who are critical stewards of many key carbon sinks. High quality projects in the voluntary carbon market can also support many other benefits nature provides: from clean water to food, medicine, supporting the UN Sustainable Development Goals (SDGs), and economic value creation – the world's GDP is underpinned by natural services, with 15% considered heavily dependent on nature.[1]

While some carbon projects benefit nature, others can have a negative impact – which undermines their positive impact on the climate. Recognizing this risk, various initiatives are looking at how projects can reduce their negative impact on nature. A key challenge is measuring impact consistently enough to enable projects to be compared. Unlike with greenhouse gas emissions and global warming, no single metric – like CO2e – exists for nature that is comparable across the Earth's diversity of ecosystems.

As a large investor and global risk manager – and a founding member of the Asset Owner Alliance and Net-Zero Insurance Alliance – Zurich has a keen interest in exploring solutions to this question. We want to see the development of a robust and credible voluntary carbon market that incorporates a metric on the wider impact of projects on nature. There is huge win-win potential in supporting nature-based carbon sequestration projects that also enhance biodiversity.

In this paper, we delve into how this potential can be realized. We look at the current state of initiatives developing metrics for biodiversity, such as the Assessment Framework and Assessment Procedure of ICVCM's draft Core Carbon Principles. Drawing on insights from Crowther Lab at ETH Zurich, we examine the role of biodiversity in this process and make the case that connecting commercial and academic thinking can help drive investment into carbon projects that support

[1] https://www.weforum.org/reports/new-nature-economy-report-series/

Chapter 1

Why nature matters to net-zero

While the priority in tackling climate change should remain on emission reductions, there is a need to maintain carbon stocks and remove atmospheric carbon to compensate for residual emissions. Growing recognition of the potential for nature to support net-zero targets has put nature-based solutions at the center of climate change mitigation efforts. Nature-based solutions – sometimes called "natural climate solutions" – can provide up to an estimated 37% of the emission reductions needed by 2030 to keep global temperature increases under 2°C, though this would require investment to triple in real terms.[2]

[2] https://www.researchgate.net/publication/320536154_Natural_climate_solutions

The UNFCCC has recognized the importance of natural solutions, including in the Paris Agreement (2015) and the COP26 Glasgow Climate Pact (2021).[3] According to the IPCC, restoration of ecosystems is one of the top five most cost-effective climate actions we can take by 2030.[4] Governments have also recognized nature-based solutions through the Leaders Pledge for Nature,[5] signed by the heads of 93 states, and the 2021 G7 2030 Nature Compact.[6] In the private sector, the Nature is Everyone's Business Call to Action[7] has been signed by more than 1,100 companies with combined revenues of more than USD 5 trillion.

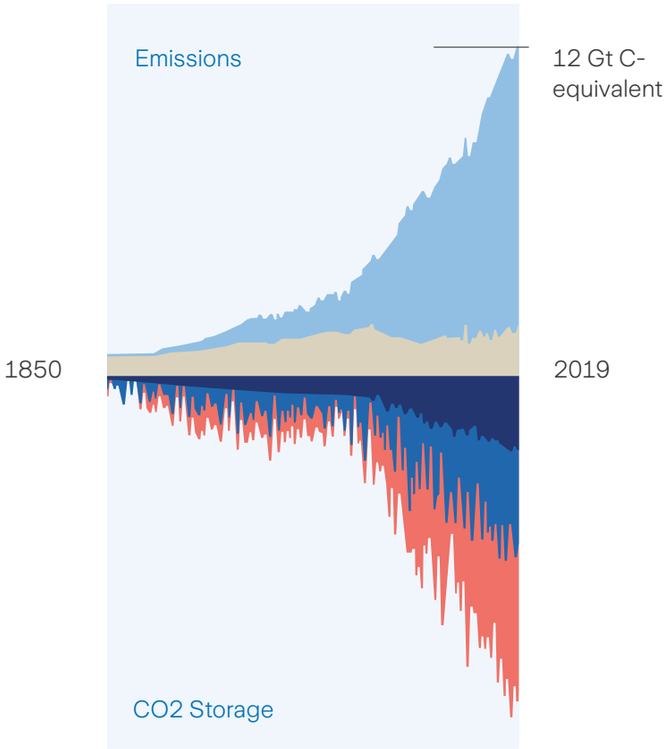
As part of the natural carbon cycle, ecosystems release and absorb around 210 gigatons of carbon per year.[8] Terrestrial and marine ecosystems are natural carbon sinks absorbing more carbon than they release.

Forests globally, for example, absorb 7.6 billion metric tons of CO2 per year – 1.5 times more than the United States emits.[9] Oceans sequester 3 billion tons per year.[10] Soils absorb 25% of the world's annual fossil fuel emissions. Without these natural sinks, atmospheric CO2 levels would be about 50% higher – well above the level compatible with the Paris Agreement's target of limiting warming to 2 degrees Celsius.

But natural sinks need to maintain their integrity, or they risk becoming net carbon emitters. As ecosystems become degraded, they release greenhouse gases to the atmosphere. Drained peatland, for example, is responsible for an estimated 4% of anthropogenic greenhouse emissions.[11]

The world's oceans are reaching their limit as increased absorption of CO2 is leading to acidification, which is impacting the productivity of marine ecosystems. However, there is an opportunity to increase the potential of terrestrial ecosystems to absorb carbon. Improved management of cultivated soils – which have lost an estimated 50 to 70% of their carbon stocks – offers major potential for carbon sequestration.[12]

Figure 1. Carbon emissions and sinks.
More carbon remains in the air
1850 – 2019

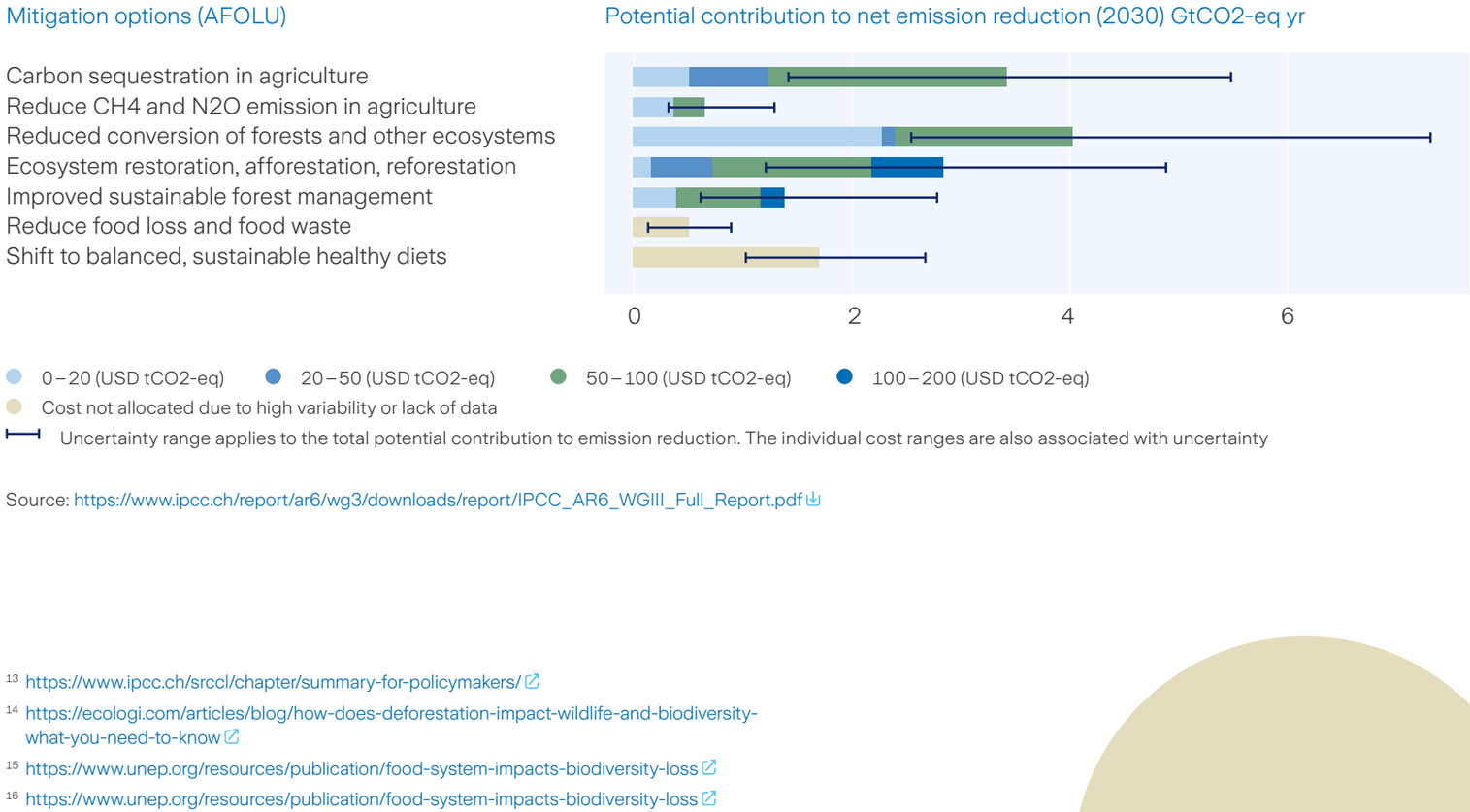


Source: https://www.dw.com/en/climate-change-emissions-data-charts-cop26/a-59652069

3 https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/
4 https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf
5 https://www.leaderspledgefornature.org/
6 https://www.gov.uk/government/publications/g7-2030-nature-compact/g7-2030-nature-compact
7 https://www.businessfornature.org/call-to-action
8 https://www.ipcc.ch/site/assets/uploads/2018/02/TAR-03.pdf
9 https://www.nature.com/articles/s41558-020-00976-6
10 https://www.nature.com/articles/s41467-020-18203-3#Sec2
11 https://www.global-wetland-outlook.ramsar.org/report-1
12 https://www.nature.com/articles/s41598-017-15794-8#:~:text=There%20is%20general%20agreement%20that,for%20Food%20Security%20and%20Climate%E2%80%9D.

Some 23% of annual anthropogenic emissions come from agriculture, forestry and other land use emissions.[13] Agriculture and forestry are also major drivers of biodiversity loss, primarily through the conversion of forests – which are home to 80% of terrestrial species[14] – to agricultural land. Food and drink production has driven 75% of deforestation to date,[15] and agriculture is considered a threat to 86% of the 28,000 species at risk of extinction.[16] Unsustainable forestry practices are also leading to degradation and fragmentation of forests, making them unviable habitats for many species.

Figure 2. Carbon removal potential and costs of mitigation actions related to agriculture, forestry and land use.



Source: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Full_Report.pdf

[13] https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/

[14] https://ecologi.com/articles/blog/how-does-deforestation-impact-wildlife-and-biodiversity-what-you-need-to-know

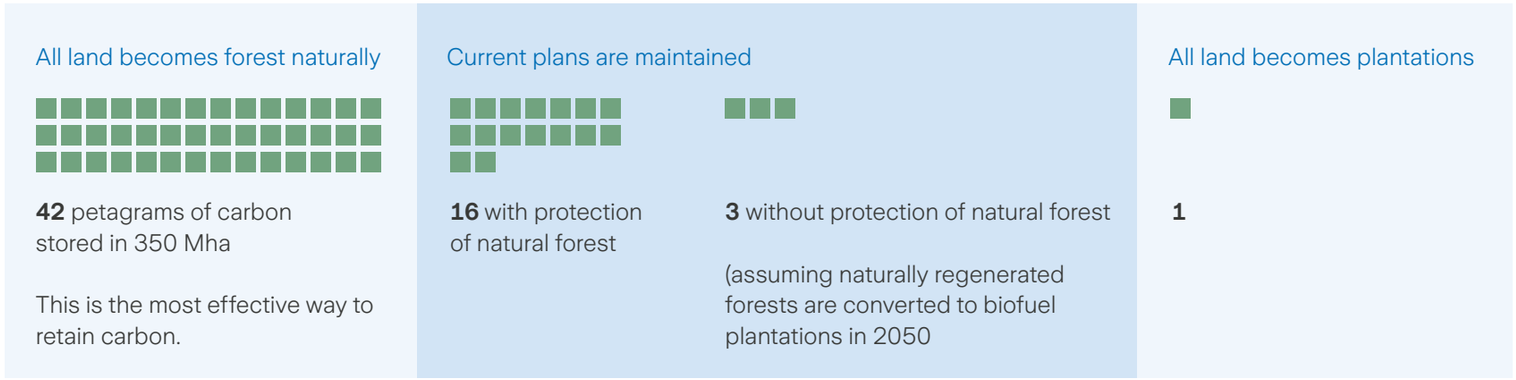
[15] https://www.unep.org/resources/publication/food-system-impacts-biodiversity-loss

[16] https://www.unep.org/resources/publication/food-system-impacts-biodiversity-loss

Tapping into the potential of nature-based solutions

Projects that focus on conserving and rehabilitating natural ecosystems, such as forests and peatlands, or promoting sustainable agricultural practices that increase soil carbon, can reduce emissions while benefiting those natural systems. Prioritizing the conservation and restoration of natural forests could be more than 40 times more effective for carbon storage than converting land to commercial plantations.[17] Yet in one study spanning 43 countries that are members of the Bonn Challenge group, only just over a third of the total area allocated for restoration was planned to be naturally regenerated.[18] Moreover, diverse natural or planted forests are far more resilient to drought, fire, pathogens and pests, and severe storms than monoculture plantations, and the severity of these events will only grow as the climate continues to change.[19]

Figure 3. Carbon sequestration and forest restoration strategies do not always follow nature's lead.
The amount of carbon stored by 2100 depends on which type of forest restoration the 43 Born Challenge countries in the analysis decide to adopt, across a total area of 350 million hectares (Mha).



Source: https://www.nature.com/articles/d41586-019-01026-8

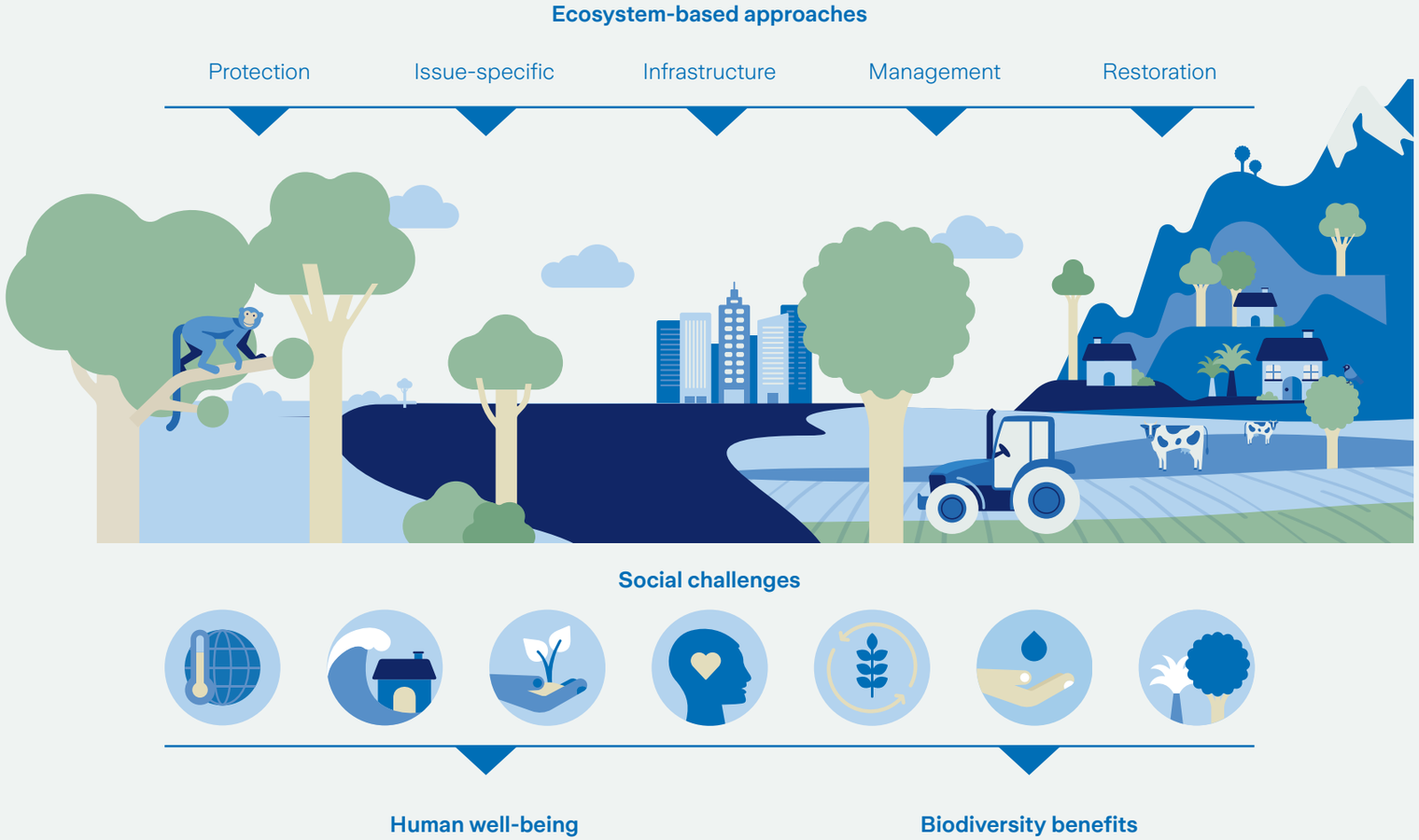
In contrast, technological solutions can be more expensive than nature-based solutions without necessarily offering the same potential. Carbon capture and storage technology, for example, can provide an effective and cost-efficient abatement approach to capture carbon at source in large heavy industries such as steel-making, cement, or ammonia and agrochemicals.[20] However, it is not yet developed at commercially viable scale as a negative emissions solution, for example in Direct Air Carbon Capture and Sequestration (DACCS). As a geotechnical carbon storage technology, CCS is also not a suitable solution for the agriculture sector, which is responsible for 23% of GHG emissions.

[17] https://www.nature.com/articles/d41586-019-01026-8
[18] https://www.nature.com/articles/d41586-019-01026-8
[19] https://doi.org/10.1111/conl.12829
[20] https://climate.mit.edu/explainers/concrete

What are nature-based solutions?

UNEP define nature-based solutions 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.'[1]

Nature-based solutions include restoring, re-establishing and protecting forests, peatlands, mangroves and other landscapes, through climate-smart agriculture, agroforestry and reforestation.[2] They are valuable not only for climate mitigation but also for their wider socio-economic impacts. For instance, the Great Green Wall of Africa initiative is creating jobs and empowering women and indigenous people as well as regenerating forests and contributing to carbon removal.[3]



[1] https://www.naturebasedsolutionsinitiative.org/news/united-nations-environment-assembly-nature-based-solutions-definition/

[2] https://4fqbik2blqkb1nrebde8yxqj-wpengine.netdna-ssl.com/wp-content/uploads/2019/09/Introduction_Available-now_NCS.pdf

[3] https://www.greatgreenwall.org/2030ambition

Natural systems not only help to mitigate climate change effects, but support adaptation. Biodiversity is critical for food security, which climate impacts threaten, and natural ecosystems are more robust and resilient to shocks such as extreme weather events. Forests, for example, help to protect nearby land against flooding and landslides, and mitigate the urban heat effect.[21]

Voluntary carbon markets: why factoring in biodiversity creates a win-win for nature and society

According to Forest Trends, forestry and land use credits accounted for 61% of transactions in the voluntary carbon market in 2021.[22] When planned well, forestry and land use carbon projects not only benefit climate mitigation but deliver on a range of benefits for society aligned with the SDGs, from job creation to ecosystem services such as improved air quality, water filtration and soil regeneration.

If carbon projects are not planned carefully, however, they can adversely impact biodiversity, climate, and local populations of Indigenous Peoples and local communities. For example, projects to plant trees often involve introducing monocultures of fast-growing non-indigenous species in places which had previously had more diverse ecosystems that were more resilient to climate change – in some cases, clearing mature forests and high-quality peat carbon stores.
New species can become invasive. Planting forests on lands not naturally forested can displace natural grassland or wetland habitats and deplete water from soils and aquifers. Monocultures also carry a higher risk of failure as carbon projects, as they are more vulnerable to drought, fire, and disease than natural forests.

[21] https://onlinelibrary.wiley.com/doi/10.1111/gcb.14656

[22] https://www.ecosystemmarketplace.com/articles/voluntary-carbon-markets-top-1-billion-in-2021-with-newly-reported-trades-special-ecosystem-marketplace-cop26-bulletin/

Biodiversity loss – a material risk to global industries

Figure 4. The proportion of gross value added exposed to nature loss in 22 global industries. (high, medium, low nature dependency)
in %, 2020

Source: http://www3.weforum.org/docs/WEF_New_Nature_Economy_Report_2020.pdf

As well as individual company efforts, groups such as the Natural Climate Solutions Alliance, convened by the World Business Council on Sustainable Development and World Economic Forum, are working to scale natural solutions for climate change mitigation.[23]

Ensuring the availability of high quality, credible and effective nature-based solutions in the voluntary carbon market will be an important enabler for business to contribute, complementing actions by government and civil society.

[23] https://www.wbcsd.org/Programs/Climate-and-Energy/Climate/Natural-Climate-Solutions/The-Natural-Climate-Solutions-Alliance

Zurich's carbon-neutral strategy

Zurich has been carbon neutral since 2014 through our work with a project on avoiding deforestation, the Rimba Raya Biodiversity Reserve. Our carbon neutrality approach has always focused on reducing operational emissions first, then offsetting remaining emissions with these high-quality voluntary emissions reduction certificates, which support programs that contribute to all 17 of the UN Sustainable Development Goals.

Rimba Raya Biodiversity Reserve, located in Central Kalimantan, Indonesian Borneo, is one of the largest REDD+ peat swamp forest projects in the world, avoiding nearly 130 million tonnes of carbon emissions. It generates carbon credits by protecting one of the most highly endangered ecosystems in the world, providing a buffer zone between the palm oil industry and the Tanjung Puting National Park, home to one of the last remaining wild populations of orangutans. The reserve also develops livelihood programs in surrounding villages to provide education, employment, and hope for the future.

Chapter 2

Voluntary Carbon Markets: growing in importance and impact

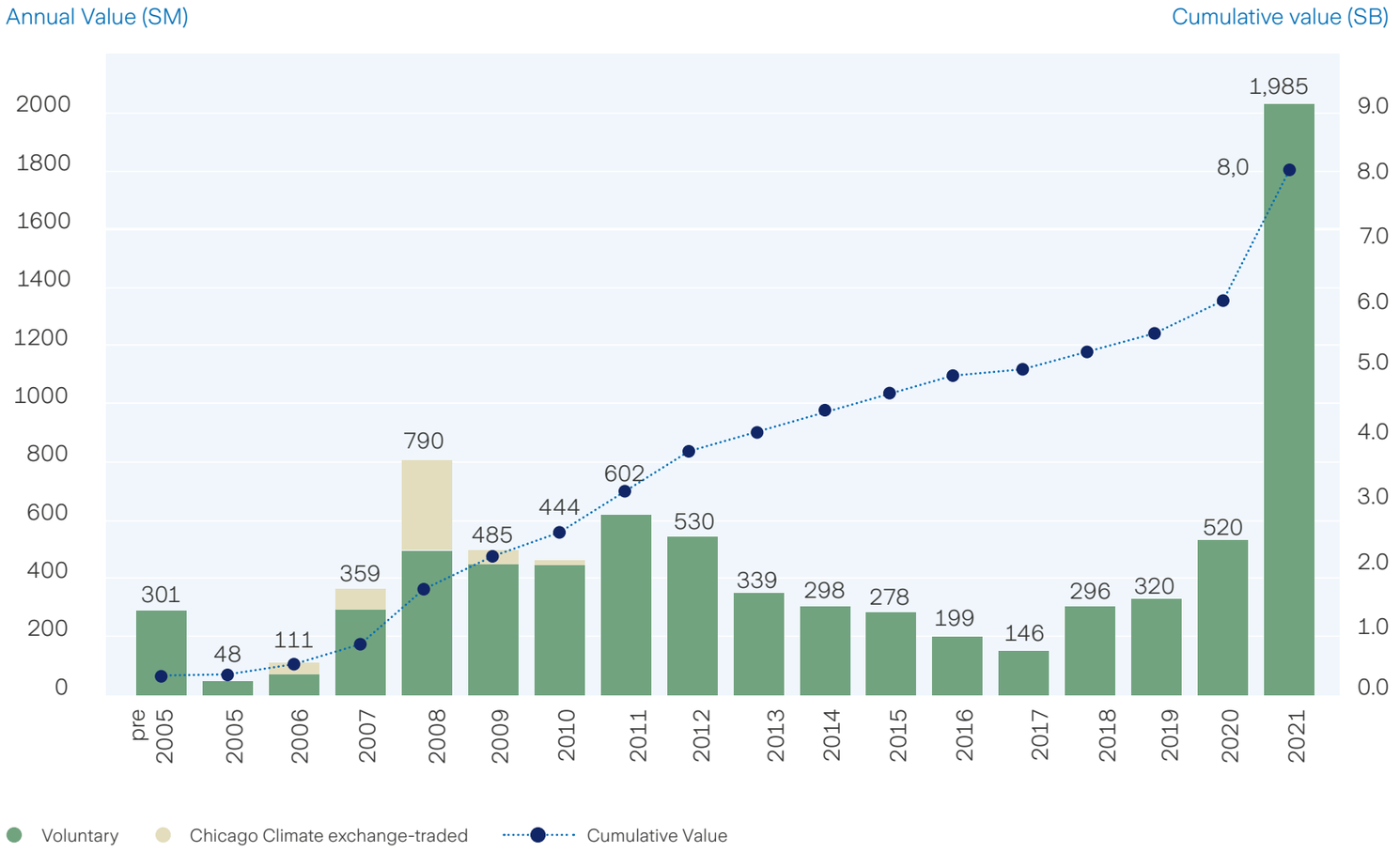
Though much smaller than the mandatory carbon market, the voluntary carbon market is growing rapidly. It quadrupled in value to around USD 2 billion from 2020 to 2021,[24] and by some estimates it could increase by a factor of 15 by 2030.[25] Within this market, demand for carbon credits generated from nature is also growing: Ecosystem Marketplace's categories of Forest and Land Use credits likewise showed a fourfold increase from 2020 to 2021

[24] https://www.ecosystemmarketplace.com/articles/the-art-of-integrity-state-of-the-voluntary-carbon-markets-q3-2022/

[25] https://www.mckinsey.com/capabilities/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

Carbon projects that avoid risks to biodiversity can be more expensive to establish, but they help to maintain ecosystems that provide multiple benefits to society and increase resilience in the longer term. According to Ecosystem Marketplace, "projects that presented benefits beyond carbon mitigation, such as community support, biodiversity conservation or contribution to the SDGs, were sold at a premium compared to others. For instance, the price of Gold Standard projects, which include co-benefits in the certification process, increased [in 2021] by 35% from US$3.74 a ton to $5.05 a ton".

Figure 5. Growth of voluntary carbon market.
in Million $, 2005 – 2021



Source: https://www.ecosystemmarketplace.com/articles/the-art-of-integrity-state-of-the-voluntary-carbon-markets-q3-2022/

Voluntary vs. mandatory carbon market

There are two types of carbon markets: mandatory (compliance) and voluntary. The compliance market is used by companies and governments that by law have to account for their GHG emissions and are regulated by mandatory national, regional, or international carbon reduction regimes. Voluntary markets function outside of compliance markets and enable companies and individuals to purchase carbon offsets on a voluntary basis. Voluntary offset credits are generally not allowed to fulfill compliance market demands.

The credibility of the voluntary market relies on all actors playing the game correctly, which requires well-researched and reported offset investments. There is significant interest from regulators in identifying credible and quality initiatives.

Source: https://www.offsetguide.org/understanding-carbon-offsets/carbon-offset-programs/mandatory-voluntary-offset-markets/

Figure 6. VCM Transaction Volumes, Prices and Values. In 2021, the volume of forest and land use credits has quadrupled surpassing renewable energy category.

	2020 Volume (MtCO2e)	2020 Price (USD)	2020 Value (M USD)	2021 Volume (MtCO2e)	2021 Price (USD)	2021 Value (M USD)
Forestry and land use	57.8	5.40	315.4	227.7	5.80	1,327.5
Renewable energy	93.8	1.08	101.5	211.4	2.26	479.1
Chemical processes / Industrial manufacturing	1.8	2.15	3.9	17.3	3.12	53.9
Waste disposal	8.5	2.69	22.8	11.4	3.62	41.2
Energy efficiency / fuel switching	30.9	0.98	30.4	10.9	1.99	21.9
Household / community devices	8.3	4.34	36.2	8.0	5.36	43.3
Transportation	1.1	0.64	0.7	5.4	1.16	6.3
Agriculture	0.5	10.38	4.7	1.0	8.81	8.7

* Note, these are annualized averages, EM Data can be analyzed more granularly by day, month, quarter, year.
** Note, these are Categories, EM Data can also be analyzed more granularly by Project Type and sub-Type.
Source: Ecosystem Marketplace, a Forest Trends Initiative.

Accelerating the impact of quality carbon offsets

If investors are to justify the additional cost of buying carbon credits from projects that do not damage – or may even enhance – biodiversity, they need to be able to demonstrate that additional impact compared to cheaper projects that save an equivalent amount of carbon.

The voluntary carbon market is moving towards greater transparency – not only on the credibility of climate impacts, which has come in for criticism, but also for impacts on nature and local communities.

Ecosystem Marketplace attributes the recent growth in the voluntary carbon market to the efforts of initiatives such as the Integrity Council for the Voluntary Carbon Market, as summarized on next page. Despite these efforts, however, there is not yet consensus – in principle or in practice – on a comprehensive approach to measuring nature-related dependencies, impacts, risks and opportunities.

There remains a need for a metric that can allow for direct comparison of projects to support buyers in selecting higher quality carbon credits. Such a metric would enable all stakeholders to evaluate the impact of initiatives, improving the credibility and quality of nature-based carbon offsets. It could improve the number of projects available to investors, addressing project pipeline issues, as various stakeholders could support their projects with better outcome modelling and analysis.

As the value of nature-based solutions becomes increasingly evident, so the need for reliable, holistic metrics is becoming more urgent. They will be critical in supporting the voluntary carbon market's contribution to net-zero and assessing the effectiveness of mandatory schemes and existing and proposed tax and pricing mechanisms.

Price of carbon

The Carbon Price Leadership Coalition, a group of businesses and governments, estimates USD 40 a metric ton as the minimum social cost of carbon – a measure of the damage done to global welfare by increasing emissions. Even that may be too low: in the International Energy Agency NZE2050 scenario carbon prices are at more than USD 200 to drive a net-zero outcome by 2050, and even higher in some NGFS (Network for Greening the Financial System) scenarios. And these prices do not consider the additional costs of integrating biodiversity into projects.

Initiatives linking voluntary carbon markets and nature

Initiatives setting standards and guidance

- **Integrity Council for Voluntary Carbon Markets** is an independent multistakeholder governance body for the voluntary carbon market. In July 2022 it launched a public consultation on its draft Core Carbon Principles and Assessment Framework and Assessment Procedure, which will set new standards for carbon credits that deliver "net positive sustainable development impacts" – including by avoiding or minimizing impacts on biodiversity and ecosystem services.
- **Voluntary Carbon Markets Integrity Initiative,** led by the Meridien Institute and supported by the UK government, addresses transparency and consistency in corporate commitments and claims to use voluntary use of carbon credits as part of their net-zero commitments. It put a draft Claims Code of Practice2 out for consultation from June to August 2022.

Initiatives promoting nature-positive strategy and policies

- **Natural Climate Solutions Alliance,** as mentioned earlier, is a multi-stakeholder group identifying opportunities and barriers to investment in nature-based solutions and carbon markets. It released Natural Climate Solutions for Corporates, guidelines for planning a credible climate strategy that includes defining the quality of credits.
- **Nature and Net-Zero** by WEF and McKinsey sets out an agenda for business leaders, policy-makers and civil society to scale up higher-quality natural carbon solutions.

Initiatives supporting companies in identifying nature-positive carbon credits

- **Carbon Credit Quality Initiative** is an independent NGO initiative that has developed an online tool to support buyers in identifying carbon credits that deliver higher climate mitigation impacts and greater social and environmental benefits.
- **Tropical Forest Credit Integrity Guide** is guidance from eight global NGOs for companies interested in purchasing carbon credits with high social and environmental integrity.

Standards and certification

- **Gold Standard** verifies carbon reductions and assesses the potential environmental and social impacts of carbon projects, and certifies only projects that implement mitigation measures where necessary.
- **Plan Vivo** certifies carbon projects with co-benefits such as poverty alleviation, gender equality, climate adaptation, biodiversity protection and water provision.
- **Verra Climate, Community & Biodiversity Standards** certifies projects that, among other criteria, benefit communities and biodiversity alongside the climate.
- **IUCN Nature-Based Solutions Standard** does not verify carbon reductions, but sets out requirements for nature-based projects to deliver on multiple benefits beyond carbon.

UN Frameworks

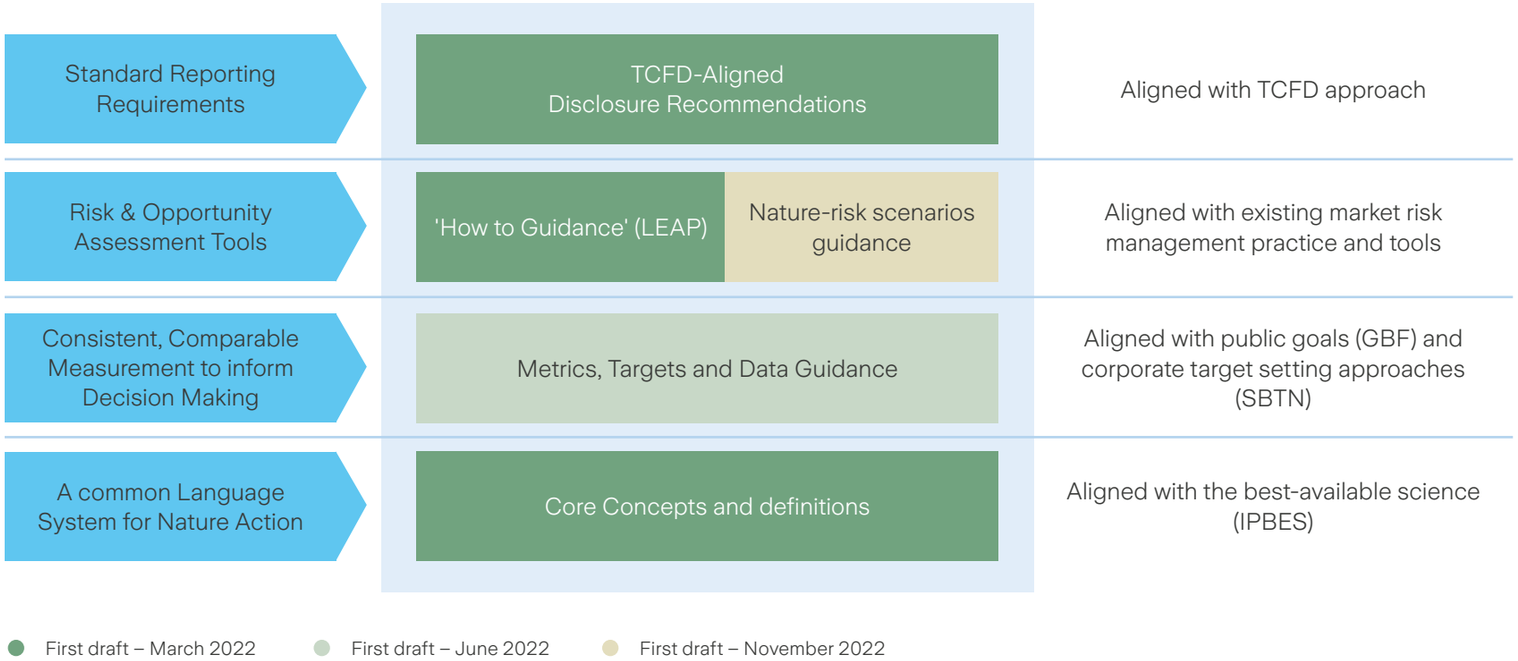
- **REDD+** is a United Nations-backed framework that aims to curb climate change by stopping the destruction of forests. REDD stands for "Reducing Emissions from Deforestation and Forest Degradation"; the "+" signifies the role of conservation, sustainable management of forests and enhancement of forest carbon stocks.

Frameworks for target setting and reporting

- **Task Force on Nature-related Financial Disclosures (TNFD)** is a group of financial institutions, corporates and market service providers set up in response to "the growing appreciation of the need to factor nature in financial and business decisions". It is developing a risk management and disclosure framework, and released the second version3 for consultation in June 2022. TNFD is also developing "LEAP" (Locate, Evaluate, Assess, Prepare) guidance that aims to help corporates and investors to understand and respond to nature-related risks and opportunities.
- **Science Based Targets Network** has set targets for biodiversity metrics, building on the Corporate Net-Zero Standard.

[1] https://icvcm.org/public-consultation/#key-resources
[2] https://vcmintegrity.org/wp-content/uploads/2022/06/VCMI-Provisional-Claims-Code-of-Practice.pdf
[3] https://framework.tnfd.global/

Figure 7. The TNFD Risk Management and Disclosure Framework



Zurich supporting carbon removal solutions

With the goal to achieve net-zero emissions in our operations by 2030, in 2021 Zurich started on the journey with our first pre-purchasing agreements for carbon removals. Our initial focus was on nature-based carbon removal solutions, which led us to biochar – a charcoal-like substance made by burning organic matter with limited oxygen at relatively low temperatures. Oregon Biochar Solutions, based on Oregon, USA, produces biochar mainly sourced from forestry waste, including fire-hazard biomass and wood damaged by forest fires. Biochar can be added to soils to improve soil health, retain water, and reduce fertilizer usage, benefiting local communities and helping maintain biodiversity.

On degraded farmland in Western Australia, InterEarth plants native trees that deal well with the arid environment. The trees are harvested and buried underground in sealed cavities. The aim is to permanently store the carbon captured within the biomass. InterEarth is proceeding with a formal pilot designed to prove that this method works as a method of carbon removal. Learn more here.

Chapter 3

Preserving and restoring biodiversity: developing a common measure of success

For the voluntary carbon market to reach its full potential in driving investment towards nature-positive projects, there is a clear need for a standard metric or approach that can properly value biodiversity.

Such a metric would help business and investors to:

- **compare projects** in a transparent way on their biodiversity impact, so they understand the impact of their credit choices on nature;
- **provide the right price incentives** to invest in climate mitigation measures that also reduce risks related to biodiversity;
- **create products and portfolios** that address interrelated sustainability challenges; and **ultimately, direct investment** into biodiversity-neutral or net positive climate mitigation efforts.

Voluntary carbon market credits could potentially be required to carry indications of their level of quality. A biodiversity metric could be one such indicator, along with others referring to social impacts.

A standard metric could also have a much wider range of applications across academic, public policy and commercial spheres. It would support governments in policy development and institutions in improving transparency and awareness for the general public. It could support UN organizations and national and regional bodies in measuring progress against international targets to protect and restore biodiversity and allow for direct comparison between government, NGO and corporate initiatives.

Measuring biodiversity

Developing a single metric is a challenge. While governments and NGOs have been assessing and monitoring biodiversity for decades, there is a huge range of approaches and data sources. A landscape assessment undertaken by the Task Force for Nature Related Financial Disclosures (TNFD) found that more than 3,000 nature-related metrics are in use today by standards bodies, policy making and regulatory bodies and in major scientific reference reports. Case studies from the TNFD review reveal a number of challenges in accessing and interpreting the vast amounts of environmental data across nature realms, biomes and ecosystem types.[26]

[26] TNFD Data landscape (https://tnfd.global/wp-content/uploads/2022/03/220321-TNFD-Data-discussion-paper-FINAL.pdf)

At present there is no standard approach that provides guidance on which elements of biodiversity to measure, which metrics to use, or how to define materiality. For a variety of reasons, scalable assessments have historically relied on indicators of a few aspects of biodiversity (e.g. mean species abundance, relative species abundance, habitat fragmentation) or biodiversity at risk (e.g. proximity to one of the world's protected areas). These data can be synthesized to draw inferences on the ecological status of an ecosystem (see more details on next page).

While important, however, these metrics ultimately provide only part of the picture when it comes to understanding the full health of ecosystems that have evolved over billions of years and facilitate huge networks of interactions across a diverse range of plants, birds, mammals, insects, microbes, fungi, and more. Unfortunately, no metrics have yet been developed to systematically quantify the full extent of diversity in an ecosystem.

What is Biodiversity? A definition

The Convention on Biological Diversity 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 at a genetic level within species, at a species level between species, and of ecosystems." [1]

[1] Convention on Biological Diversity, UNEP/CBD/94/1

Examples of biodiversity data providers and platforms

- **Global Forest Watch:** established by World Resource Institute in 1997, this open-access online platform now provides near real-time data about forests – including carbon dynamics – at a resolution of 30x30m.
- **Land and Carbon Lab** at University of Maryland: building on Global Forest Watch maps, a monitoring system integrates other high-resolution data on metrics such as biodiversity and ecosystem services to provide near-real-time alerts on ecosystem conversion, degradation or restoration.
- **Global Biodiversity Information Facility:** an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth.
- **Nature Map:** recently launched by the International Institute for Applied Systems Analysis, Instituto Internacional para Sustentabilidade, the UN Sustainable Development Solutions Network and the UN Environment World Conservation Monitoring Center, Nature Map uses both local and spatial information to map areas of global significance for conservation, restoration of biodiversity and carbon storage.
- **Integrated Biodiversity Assessment Tool:** provides datasets on protected areas, key biodiversity areas and the IUCN Red List of Species.
- **Crowther Lab:** an interdisciplinary research group that brings together a global network of ecologists and practitioners to build models that detect global patterns in biodiversity from local observations to understand the status of, and capacity to restore, ecosystems. They combine ground-sourced data with machine learning approaches to map global distribution of soil fauna and the "wood wide web" – both important for carbon cycling. In 2021 they launched Restor, an online map of sites across the globe where land is being managed for biodiversity, enabling the public to engage in community-based restoration.

The Zurich Forest Project

The Zurich Forest project supports non-profit organization Instituto Terra to regrow part of what was once the largest single wooded place on Earth: the Atlantic Forest in Brazil. It is re-creating a native forest on land that was a barren cattle farm just 20 years ago, restoring the biodiversity of plants and animals, protecting soil, and reviving and maintaining water sources. Zurich's grant covers the planting of one million seedlings of up to 120 scientifically selected native species.

Deploying new technologies to monitor biodiversity over time

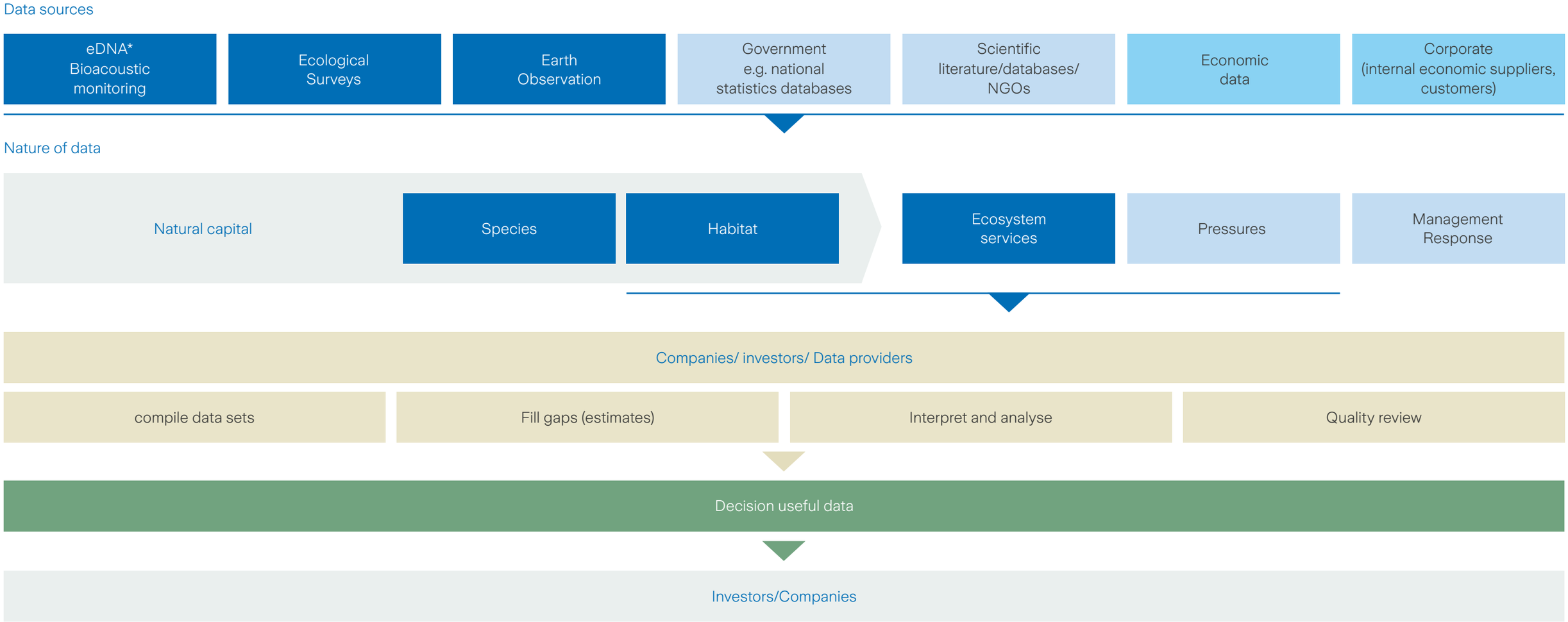
New approaches are being developed that offer the potential to monitor ecosystems. These approaches combine technologies such as satellite imagery, genetic analysis, digital systems and machine learning.

Environmental DNA (eDNA), for example, involves the analysis of DNA samples from water, soil, or organic matter. An approach known as eDNA metabarcoding can be used to detect single species or a spectrum of taxonomic groups generally found in an environment from a single environmental sample. It offers the opportunity to link field-collected data to earth observation data to gain insights on a large scale and track changes in near-real-time.

Bioacoustics involves the analysis of animal sounds to identify the presence of individual species or the diversity of species groups. Initially used with birds, an emerging field of research is now using the "soundscape" of an ecosystem as an approximate measure of biodiversity more widely, including seasonal and daily variation in species richness.

Remote-sensing technologies are increasingly important in conservation management. They can deliver data on the quantity of habitats – the amount and configuration – as well as their quality, considering factors such as structure, distribution of individual plant species, habitat types and/or communities and persistence. Data from VHR (very high resolution) satellite imagery can give an overview of changing landscape patterns through time.

Figure 8. Biodiversity data landscape.



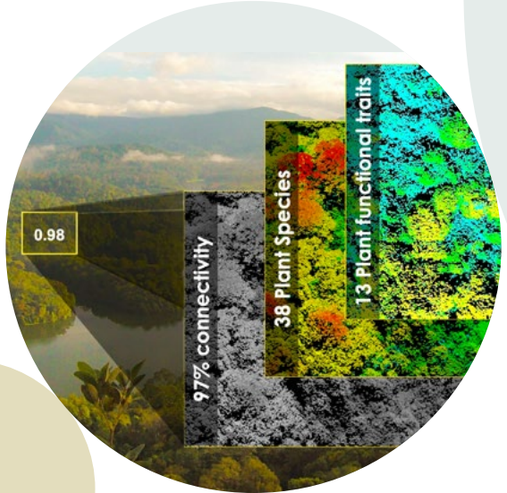
*eDNA is a way of assessing using samples from the environment e.g. water, soil. Based on DNA present, species presence can be determined and biodiversity assessed.

The challenge: a biodiversity assessment that captures the multidimensionality of diversity

When a single aspect of nature is valued more highly than others, there is a danger of propagating that single aspect at massive scale at the expense of everything else. We have seen that with vast areas dedicated to production of a small group of crop species for food, timber, and textiles. There is a risk of taking the same approach with carbon, with the negative impact on nature potentially outweighing the climate benefits. The challenge is finding approaches that bring transparency and accountability in an effort to promote ecological health.

As noted above, there is no shortage of environmental data – instead, the challenge is how to harness existing data to generate a more holistic measurement of biodiversity and how it is changing over time. As regulations are introduced requiring companies and countries to disclose where they are operating and the state of the ecosystems they are impacting, we need to be able to monitor how the biodiversity of the ecosystem is changing.

Through a Biodiversity Index Partnership with Nature Finance, and other academic collaborators, Crowther Lab has established the SEED Biocomplexity initiative to do just that. SEED's Biocomplexity Index can dovetail with the developing TNFD risk management and disclosure framework, including the LEAP guidance.



SEED's Biocomplexity Index

- The world's first assessment of biological complexity ("biocomplexity") to quantify the full extent of genetic, species and ecosystem diversity, and their variation through time.
- With geocoordinates for an area of interest, or "asset", any organization can create a multidimensional biocomplexity assessment. An assessment value close to 1 indicates natural levels of biocomplexity for a given ecoregion, while an assessment closer to zero suggests that the area is being managed in a way that reduces biodiversity.
- The value of this approach is that it draws on the full range of environmental data, as well as being scalable and cost-effective. It can provide deeper biodiversity insights without undertaking intensive, and often expensive, local biodiversity assessments. As with any modelling approach, there are some areas of uncertainty; however, enough ground-truthed data exists to reduce the level of uncertainty at large spatial scales (thousands of hectares).
- Using this approach a company could, for example, assess the biodiversity impact of all its assets on a portfolio basis. By understanding changes in biodiversity in any one asset and comparing to other assets, companies can better understand the reasons for change and take action to improve management.
- SEED's standardized assessment approach could potentially be integrated into carbon markets. For example, the value of the carbon credit could be multiplied by the biocomplexity value for that asset. A monoculture plantation might have a high carbon value, but it would be multiplied by a biodiversity impact of 0.1, which would reduce the value of that credit by 90%.

SEED's Biocomplexity Index – potential use case

The diagram below provides an example of what SEED's biocomplexity assessment would look like for a selection of carbon project sites. A similar portfolio approach could be applied to an agricultural supply chain or an asset manager's portfolio of regenerative investments.

SEED is currently working with Nature Finance and social scientists to stress test the approach to ensure it promotes equitable outcomes for local stakeholders. While the index aims to provide a more complete picture of biodiversity, land managers, community stakeholders or investors may also want to run complimentary analyses that are important for their purposes (e.g. assessments of dependency risk or the relationship between biocomplexity and specific ecosystem services).

Illustrative analysis: SEED Biocomplexity assessment for carbon projects

Intervention type	Site area	SEED Biocomplexity Performance (95% confidence)	2021 SEED assessment	Final Assessement (incl. site data)	
Natural regeneration	(ha)	2000 2010 2021	(95%)	Index	(95%)
Site 1	200	0.2 … 0.7	0.6-0.8	0.7	N/A
Site 2	800	0.45 … 0.5	0.4-0.6	0.56	0.5-0.6
Site 3	1	0.6 … 0.4	0.1-0.6	0.35	0.4-0.5
Site 4	15	0.2 … 0.2	0.1-0.4	0.2	N/A
Site 5	8	0.2 … 0.5	0.25-0.75	0.5	N/A
…	…	…	…	…	…
Total	2,039	0.3 … 0.4	0.38-0.42	0.45	0.44-0.46

Source: ETH Zurich, Crowther Lab

By grouping sourcing sites together over large spatial scales, SEED can monitor change in biocomplexity with a higher degree of certainty, without the need for detailed and expensive site assessment.

Where ground data is available SEED's data scientists will design pipelines to ingest data and test whether we can further improve the certainty of the assessment.

Conclusions and recommendations

Given the importance of meeting net-zero targets, the central role of biodiversity in supporting climate mitigation efforts, and the need to mobilize the private sector to regenerate ecosystems, Zurich sees the alignment of the voluntary carbon market with biodiversity as being of utmost importance. But Zurich also recognizes the very real risks of valuing one aspect of nature – carbon – more highly than any others, and the absolute need to promote the full biocomplexity of ecosystems in order to promote planetary health and resilience.

A globally agreed biodiversity metric that can be readily integrated into carbon projects is key to transforming the voluntary carbon market into a driver of positive outcome for biodiversity. An ideal biodiversity metric should be:

- Granular enough to be used at the project level
- Standardized in what it measures and how the measurement is recorded
- Robust enough to enable comparisons over time and between sites around the world in diverse ecosystems
- Scalable across multiple project locations and portfolios
- Aligned with global policy frameworks and standards including multilateral government frameworks and corporate target-setting and reporting
- Communicable so it can be easily understood by a general audience as well as by investors, policy-makers and regulators.

Business, governments, scientists, and NGOs need to collaborate to fast-track the development of such a metric. Many challenges remain that will need further scientific and technological progress. However, the SEED Biocomplexity initiative shows that scientists are developing the tools for companies to make more informed decisions that benefit not only people and climate, but nature too.

To further operationalize the link between carbon offset projects and biodiversity, stakeholders at national and multilateral levels should:

- Support collaboration among academics, multilateral organizations, business, governments, and NGOs in the development of biodiversity measurement methodologies and the deployment of new technology solutions to support them.
- Promote collaboration among existing initiatives, public and private, to better align voluntary carbon market investments with positive biodiversity outcomes; via:
  - Principles/guidelines recognizing biodiversity as an important element of climate mitigation and adaptation and net-zero efforts.
  - Common recommendations on the best practice for biodiversity metrics to evaluate the net impact of nature-based carbon offset investments on biodiversity.
  - An international register or clearing mechanism to log and review initiatives, offering prospective partners a robust project pipeline.
- Engage with policy-makers to clarify that investments in nature do not come at the expense of decarbonization or clean tech and recognize the importance of biodiversity value to net-zero targets in the regulation of carbon markets and tax mechanisms, to align public and private action and incentives.

- Identify a lead organization or group, within the UN or from another neutral global organization, to coordinate and drive the above and accelerate the impact of measurable net-positive offset investments via the voluntary carbon market. This group could also work to:
  - identify the main technical, institutional, capacity, and resource gaps and challenges, and
  - make recommendations to governments, multilateral organizations, business, and NGOs.

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