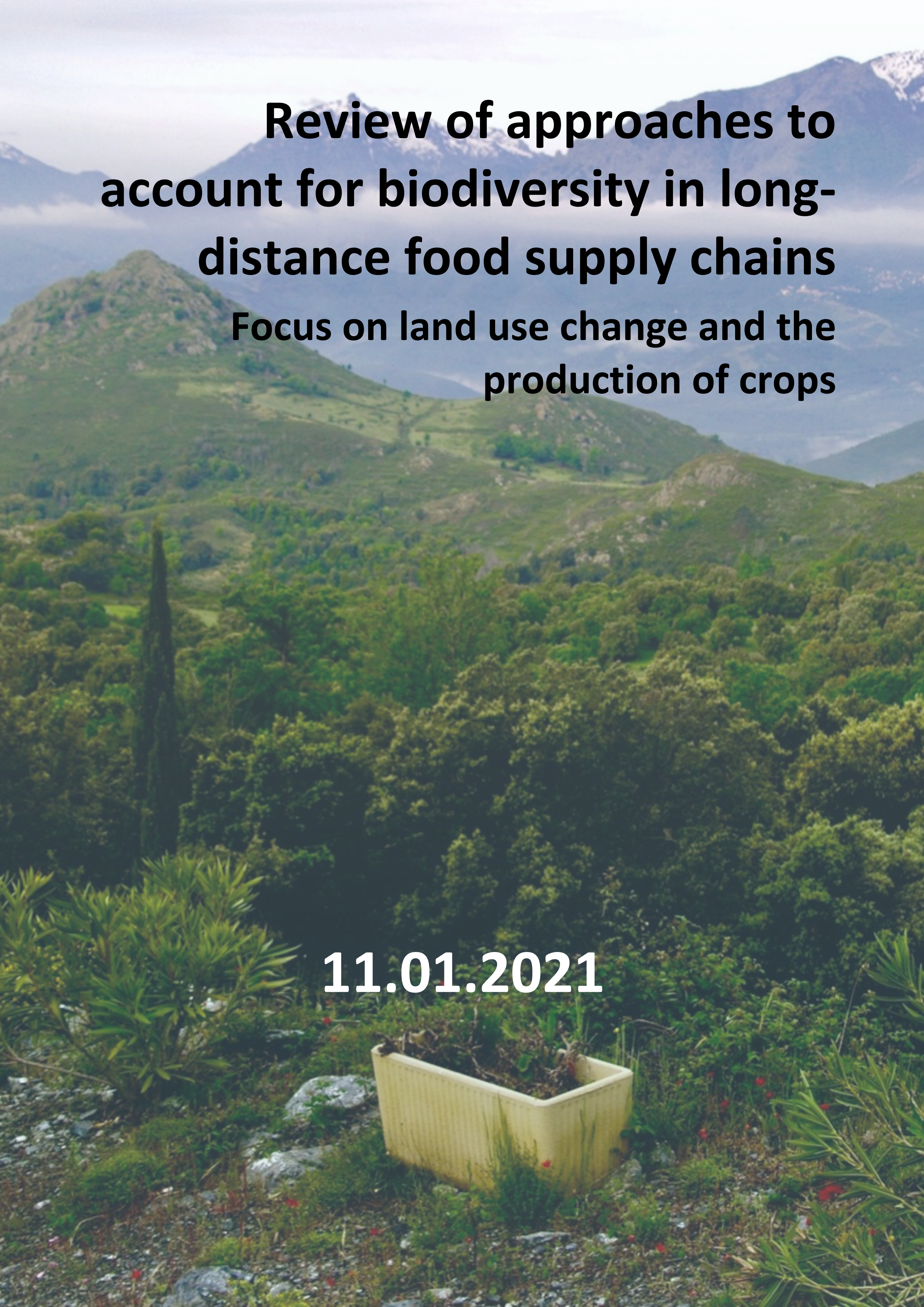
# Review of approaches to account for biodiversity in long-distance food supply chains

## Focus on land use change and the production of crops



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## Focus on land use change and the production of crops

Authors: Meghan Beck-O'Brien and Stefan Bringezu
*Center for Environmental Systems Research (CESR), University of Kassel*

Acknowledgments: With kind contributions and comments from Marion Hammerl[1], Annekathrin Vogel[1], Stefan Seuring[2] and Vincent Egenolf[3]

*[1] Bodensee-Stiftung*
*[2] Faculty of Business and Economics, University of Kassel*
*[3] Center for Environmental Systems Research (CESR), University of Kassel*

Project: Actor-oriented risk classification of origins of agricultural products based on global spatially differentiated impacts on biodiversity

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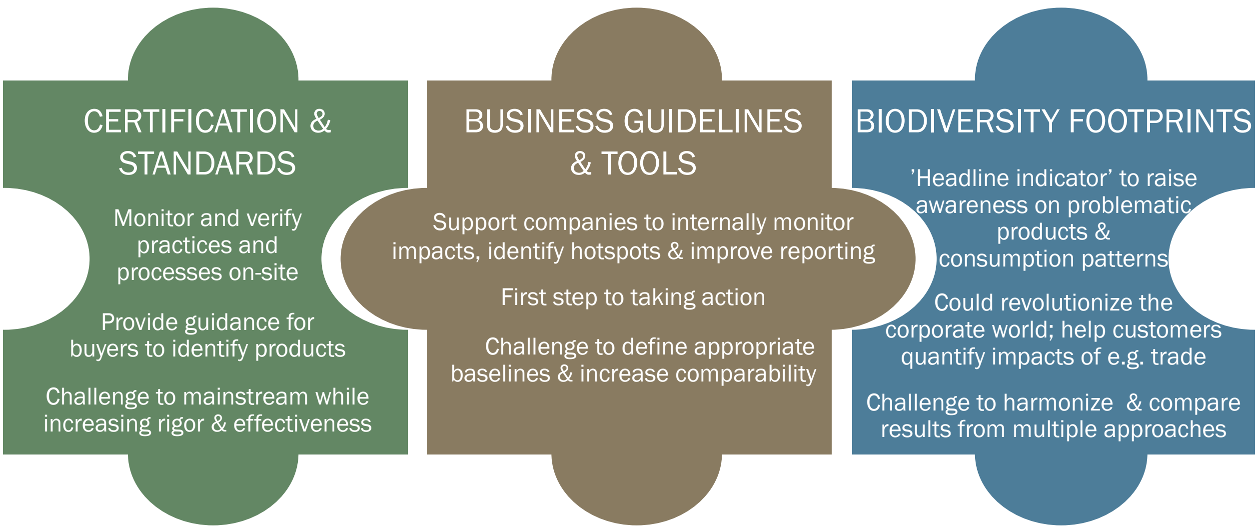
# KEY MESSAGES

- The urgency and need to do more for conserving biodiversity is well established. None of the global biodiversity targets were met by 2020 and progress is stagnant or even worsening in many cases. Rampant loss of biodiversity and ecosystem services undermines the resilience of food systems.
- Biodiversity monitoring systems have been used by conservation projects for many years. Multiple efforts are underway to adapt these for business needs, in particular to account for indirect pressures (like land clearing) at the start of supply chains where food is sourced and to expand environmental certification to include biodiversity-focused practices on and around farms.
- Tools for observing and assessing biodiversity serve different roles. They respond to distinct questions about what is monitored (e.g. processes on-site, pressures on landscapes, impacts on species), at what scale (e.g. specific products, company performance, country-wide consumption levels), and compared to which baseline (e.g. pristine nature, alternative scenarios, targets). This has implications on the type of data needed (e.g. collected on-site, compiled from satellite images, derived from modelling), and the robustness of results. Some applications must be easy-to-communicate (raise awareness) whereas others are used internally to help identify risks and implement changes across value chains.
- With the exception of promising frontrunners, current use of tools in practice is weak. Most of the existing food standards do not include biodiversity related criteria—or the criteria is weak. Certification of high-impact crops such as coffee, cocoa, palm oil, and soybeans have seen incredible market growth. However, their combined coverage of total agricultural area is less than 1%. This points to a spatial-scale mismatch between the level of certification achieved and the level needed to effectively halt biodiversity loss and land conversion. Higher levels of certification—including more crops and commodities—as well as complementary approaches that address pressures at higher scales (like footprints at country level) could help to fill this gap.
- The degree of change needed to ensure food security for future generations requires moving beyond incremental adjustments. There is widespread scientific consensus on the need for higher levels of ambition to keep food systems operating within planetary boundaries. Through new guidance, companies can now upscale or downscale their impacts to the planetary boundary target framework. For the food industry, ethical supply chains—characterised by zero deforestation commitments and/or regenerative agriculture—could signal their dedication to shifting mindsets from "doing less bad" to "doing good".
- Business can take the lead toward sustainable food systems. The food industry is in a position to both demand higher levels of biodiversity inclusion from suppliers and help customers to make more sustainable choices (prioritisation, no-go products, etc.). Business-science partnerships may help to develop appropriate monitoring tools; public-private partnerships could ensure that conditions for directional-safe change will be met.

**FIGURE 1. COMPLEMENTARY APPROACHES AVAILABLE FOR BUSINESS TO ACCOUNT FOR THEIR BIODIVERSITY IMPACTS**



# 1. INTRODUCTION

The food sector is both highly dependent on biodiversity and heavily contributing to the loss of biodiversity. The urgency and importance of conserving biodiversity has been well recognised by stakeholders across all levels of governance, business and civil society throughout the world. However, none of the major international biodiversity targets (e.g. Aichi targets) were met by 2020. Instead, **the rate of biodiversity loss is accelerating**.

The food sector is a major player and there are a host of new tools, monitoring systems and initiatives tackling the biodiversity challenge from different angles and perspectives. This means that different stakeholders have widely different perceptions of what it means to develop, use and apply biodiversity criteria that should halt biodiversity loss at the farm level, in the regions of origin, across supply chains and associated with the consumption of food products stemming from long-distance production. **This paper looks at the scope of activities across multiple levels and scales to provide a common basis for discussion**. It aims to review methods of how food products can be related to biodiversity impacts at the beginning of their upstream production. It has a particular focus on improving the knowledge basis toward halting biodiversity loss associated with land use change.

This is the first output of the "AKRIBI"[1] project. The overarching project aim is to develop a relevant and practicable method enabling companies to quantify, assess and control the impact of their supplies on biodiversity in the regions of origin. The aim is to support business to be able to make more strategic decisions about where the risk of farming and/or sourcing of food products is too high, in particular, as regards likely contributions to detrimental land use change. The method shall be based on and **shall complement existing efforts to** monitor and account for biodiversity in e.g. standards and certifications (focusing on site-specific inclusion of biodiversity practices), corporate initiatives (including company level reporting and disclosure) and science-based modelling (e.g. biodiversity footprints across multiple scales). Project outputs of the first phase of the project include documentation from three stakeholder workshops and a feasibility study based on the outputs of the stakeholder workshops and insights generated.

**This paper targets members of the business community**--in particular the food industry--with ranging levels of existing expertise (newcomers to experts), NGOs, and the informed public actor. It is intended to be a short and accessible report. Tables with further information are presented in the Annex and boxes provide short examples of best practice or key resources. We begin with a broad overview and definition of biodiversity, before focusing on the challenge and role of the food sector specifically. This approach is also applied to Chapter 3 on goals and Chapter 4 on methods. In this way, related data sources and accounting methods—from e.g. other sectors—which could be useful for the food industry are also examined.

Altogether this paper aims to **provide clarity into the scope of different types of biodiversity monitoring activities, improve understanding of how they complement each other and highlight potential gaps from a system perspective**. It shall provide a basis for the stakeholder workshops and also pave the way for the feasibility analysis looking at the opportunities and challenges of different approaches from a stakeholder perspective.

[1] Actor-oriented risk classification of where agricultural products are sourced based on globally differentiated and spatialized assessment of biodiversity pressures [Akteursorientierte Risikoklassifizierung von Herkünften agrarischer Produkte auf der Basis weltweit räumlich differenzierter Auswirkungen auf Biodiversität].

# 2. BIODIVERSITY AND THE FOOD SECTOR

*"Meeting the world's increasing demand for food while still reducing agriculture's environmental impacts is one of the defining challenges of our times."* - IPBES (2019)[2].

## 2.1. DEFINING BIODIVERSITY: FROM GENETICS TO EARTH SYSTEMS

Simply put, biodiversity refers to the variety of life on Earth[3]. It is assessed across multiple levels. For example, *species diversity* describes the variability of all plants, animals and microorganisms while *genetic diversity* describes the variety of chromosomes, genes and DNA unique to each individual and species. *Ecosystem diversity* refers to the variety of ecosystems (e.g. deserts, forests, wetlands, agricultural landscapes, etc.) which enable populations of species to interact, adapt and evolve. Indeed, the wide variety of biodiversity seen today is a result of 3.5 billion years of evolution. This means that in order to preserve biodiversity, not only maintenance of species and genetic diversity is needed, but also efforts to **enable a dynamic interaction within and between different ecosystems**. Ecosystem services are defined as "the benefits people obtain from ecosystems" (MEA 2005) or "nature's contributions to people" (IPBES 2019). They include not only regulating services (e.g. climate regulation or flood and erosion control), but also provisional (e.g. crops), supporting (e.g. nutrient cycling) and cultural services (e.g. spiritual and recreational).

**Currently around 25% of species assessed in animal and plant groups are threatened**; the global rate of species extinction is ten to hundreds of times higher than average rates over the past 10 million years, and it is accelerating (IPBES 2019). Habitat loss and fragmentation are the biggest drivers of species loss, followed by pollution, poaching and invasive species. This had led to conservation actions focused on e.g. protecting critical habitats. The IUCN provides a "Red List"[4] of species at risk of extinction and has also led the effort to identify "Key Biodiversity Areas"[5]. Scientists estimate that globally there are 847 ecoregions[6], characterised by unique communities or groups of species not found elsewhere. Species extinctions at these local to regional levels – even when not threatened globally – erode the ecosystem services essential to civilisation in what some have described as a **mass extinction event**, the sixth in Earth's history and the first induced by humans (Ceballos et al. 2015; 2017). This suggests that more widespread action and stronger targets are needed. While the alarming rate of biodiversity loss continues, it is also estimated that "the rate of decrease in extinction risk for birds, mammals and amphibians would have been at least 20 per cent higher without conservation action in recent decades" (IPBES 2019).

Biodiversity is characterised as one of nine **planetary boundaries.** These describe tipping points for major Earth operating systems, beyond which the risk of irreversible change will push the Earth from the relatively stable Holocene (characterised by a mild climate enabling 10,000 years of development) into an uncertain future (Rockström et al. 2009, Steffen et al. 2015). The biodiversity planetary boundary is accounted for as **the sum of species and ecosystem dynamism** which play important roles in

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[2] The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) carried out a major global assessment of biodiversity and ecosystem services including about 150 selected experts from all regions of the world, assisted by 350 contributing authors and analysing more than 15,000 scientific publications as well as a substantive body of indigenous and local knowledge. It can be accessed online: www.ipbes.net/global-assessment.

[3] It is defined as: "The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems." See the glossary of the IPBES: https://ipbes.net/glossary

[4] Founded in 1964, it is the world's most comprehensive inventory of the global conservation status of biological species. It documents the global conservation status of over 85,000 plants and animal species and sub-species, based on a set of clear criteria for assessing their extinction risk. More information at: iucnredlist.org

[5] Key Biodiversity Areas (KBAs) are "the most important places in the world for species and their habitats". The KBA Programme helps to identify, map, monitor and conserve KBAs. More information: keybiodiversityareas.org

[6] For a map see: ecoregions2017.appspot.com

biogeochemical cycles (carbon, water, etc.) and for regulating climate (e.g. as stocks). This highlights the interconnectedness, importance and urgency of conserving biodiversity from a planetary perspective. The calculated planetary boundary for biodiversity is one of four which has been exceeded (see Table 7.1 in the Annex for a breakdown of all 9 boundaries and their implications for and from a business perspective) (Steffen et al. 2015, CISL 2019).

## 2.2. LAND USE CHANGE DRIVES BIODIVERSITY LOSS

Drivers of biodiversity loss are often divided into 'direct' and 'indirect' forces (MEA 2005). This refers to the immediate cause (such as clearing forest for agriculture) resulting from an array of underlying causes (such as the values that underpin consumption preferences and drive demand). According to the IPBES (2019): "Globally, land-use change is the direct driver with the largest relative impact on terrestrial and freshwater ecosystems". **This leads to both habitat loss and fragmentation**. Deforestation, while slowing down since the year 2000, still heavily impacts some of the planet's most biodiverse regions. Tropical and subtropical forest loss is increasing in some countries. Climate change is highly connected to land use change as both a driver and a result, exacerbating challenges. An analysis of the proportion of threatened species on the IUCN Red List (mammals, birds, amphibians) affected by each driver revealed that more than 80% are under threat from habitat loss, 70% from overexploitation and unsustainable use, and almost 30% from invasive alien species.

## 2.3. THE ROLE OF FOOD SUPPLY CHAINS

The food industry has a role to play as regards two overarching aims: (1) halting biodiversity loss and (2) ensuring that biodiversity is able to provide core services that enable life on Earth. These aims lead to complementary approaches. It implies for (1) that **halting land use change** is a high priority in order to help preserve intact natural ecosystems e.g. rich in biodiversity. It also means for (2) that i**ntegrating practices that help to preserve biodiversity on and around farms** is crucial to ensuring ecosystem services over the long term.

### 2.3.1. FOOD SECURITY IS DEPENDENT ON BIODIVERSITY

The resilience of food production systems is under threat. Biodiversity is the basis for soil fertility, pollination and pest control; it is critical to water security. For example, more than 75% of global food crop types depend on animal pollination. With pollinator diversity in decline, up to $577 billion in annual crop output is under risk (IPBES 2019). Around 23% of the global terrestrial area has reduced productivity due to land degradation. **The loss of diversity underpinning agricultural systems is seen as one of the most pressing challenges of this century**. Further the loss of diversity within food production systems—due to fewer varieties and breeds of plants and animals under cultivation--is **making agricultural systems less resilient against future climate change, pests and pathogens**. For example, over 9% of domesticated breeds of mammals used for food and agriculture were extinct by 2016 with at least 1,000 more under threat. A 70% decline in the cultivation of native plant varieties was observed in the Asia-Pacific region, with reductions in genetic resources (IPBES 2018b). Many crop wild relatives, which are important for long-term food security, also lack effective protection (IPBES 2019).

Sustainable food systems[7] are fundamental to future generations. A sustainable food system is "a food system that delivers food security and nutrition for all in such a way that the economic, social, and environmental bases to generate food security and nutrition for future generations are not compromised" (HLPE 2014). UNEP (2019) emphasises that **the current focus on food production is not solving food systems issues.** While the world produces enough food to feed all of its population, almost

[7] Food systems gather all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation, and consumption of food and the outputs of these activities, including socioeconomic and environmental outcomes (HLPE 2014).

800 million people go hungry and two billion are malnourished[8] (HLPE 2017). The **FAO estimates that by 2050, food production will have to increase by some 50% in order to satisfy the demands of a growing and wealthier population, with an increased demand for meat** (FAO 2017). The UNEP (2019) report argues for "a food systems approach to policymaking and implementation … resulting from enhanced cooperation among food systems actors and addressing the drivers and trends of both unsustainable food production and consumption". Including consumption drivers behind food production practices is integral to this effort (e.g. consumer preferences for processed livestock products and fast food, as well as lifestyles, education, etc.). The food industry will have a clear role to play to this end (Section 3.4). The UNEP (2019) report also explicitly recognises that "**Food systems are functioning within the context of a finite and shrinking resource base".** Policymakers are not, yet, fully considering the value of biodiversity and ecosystems services. As a consequence, food is undervalued and food prices do not reflect the true cost of production (TEEB 2018). A shift will require public-private partnerships and widespread awareness raising, for which monitoring is the first step. Altogether, "our paradigm of growth needs to broaden its boundaries beyond primary production and include efficiencies along the whole food chain, along with promotion of sustainable practices and diets" (UNEP 2019).

## 2.3.2. LAND USE CHANGE IS DRIVEN PRIMARILY BY AGRICULTURE

Agricultural expansion is the biggest driver of land-use change. **Over one-third of the terrestrial land surface is used for cropping or animal husbandry**. More specifically, cropping occurs on 12% of total ice-free land and grazing on 25% of total ice-free lands and approximately 70% of drylands. Agricultural area increased by over 100 million hectares between 1980 and 2000 across the tropics, half at the expense of intact tropical forests (Gibbs et al. 2010). Pasture for cattle contributed to the largest agricultural land expansion in Latin America. Sugarcane and soybeans also play a critical role in expansion in South America. Rice, wheat, millet, and sorghum dominate South Asia, which also saw a huge expansion in oil palm plantations, in particular in the 1990s. Agricultural expansion in Africa is largely dominated by farming for subsistence, characterised by small plots for sorghum, maize and millet (Gibbs et al. 2010, Ramankutty et al. 2008). **A key indirect driver of land expansion for agriculture is shifts toward animal-based diets** (Alexander et al. 2015, Rask and Rask 2011), possibly overriding population growth as the largest driver (Kastner et al. 2012). To put the extent of agricultural land into perspective, urban areas (settlements and infrastructure) cover around 3% of the Earth's surface[9]. These areas are also expanding rapidly, most often at the expense of fertile cropland, which then displace grasslands, savannahs and forests (Holmgren 2006, UNEP 2014).

## 2.3.3. AGRICULTURAL PRACTICES: DESTROYING OR INTEGRATING BIODIVERSITY

"Impacts from agriculture are huge" (IPBES 2019). Almost three-fourths of available freshwater resources are used for crop or livestock production and one-fourth of greenhouse gas emissions are from land clearing, crop production, and fertilisation (Burney et al. 2010). A recent analysis of 60 cases found that **agricultural intensification rarely leads to win–win social-ecological outcomes**; food or provisioning services are improved, but with mixed outcomes for regulating services (Rasmussen et al. 2018). For instance, between 1960 and 2015 water withdrawals and pesticide use doubled, fertiliser use tripled, chicken density increased 10-fold, and cattle density rose by 20% (IPBES 2019b). Fertiliser run-off has led to more than 400 hypoxic zones – or dead zones—in freshwater and coastal ecosystems. Between 1985 and 2005 crop production rose 47%, yields increased 28%, and global crop and pasture lands rose 3%, mostly in the tropics (Foley et al. 2011, Poore and Nemecek 2018). **Livestock production uses one-third of crop production for feed and three-quarters of agricultural land in total**, with

[8] At the same time, the number of overweight people worldwide has reached more than 1.9 billion adults, with over 600 million classified as obese (HLPE 2017).

[9] Global Urban Rural Mapping Project; https://sedac.ciesin.columbia.edu/data/collection/grump-v1

consequences for nature as animal-based foods, and especially beef, require more water and energy than plant-based foods (Ranganathan et al. 2016).

**While the impacts as a whole are severe, widespread efforts to increase biodiversity and ecosystem services exist.** For example, varied permaculture, agroforestry and agro-silvo-pastoral systems allow maintenance of biodiversity, lower degradation and increase ecosystem services. It is estimated that small-scale (less than 2 hectares) farms produce around 30% of global crop production, using 24% of land, and with high agrobiodiversity (Ricciardi et al. 2018). **Organic agriculture** has increased over recent decades, including in larger-scale farming systems, and covered over 31 million hectares in 120 countries by 2006 (Alexandros et al. 2012)[10]. Some researchers have found that such systems produce variable outcomes, finding that they may improve biodiversity, soil and water quality and nutritional value, although not always providing higher yields when compared to large-scale monocropping (Seufert & Ramankutty 2017).

**BOX 1. AGRICULTURE FOR BIODIVERSITY: PROJECT FOCUSED ON ORGANIC FARMING IN GERMANY**

The decline and loss of wild animal and plant species in Germany and Europe is dramatic, especially in intensively used agricultural areas. Organically managed farms have been shown to have a much higher potential for increasing biodiversity than their conventional counterparts. The project "Agriculture for Biodiversity" aims to demonstrably increase the diversity of wild animal and plant species in agricultural landscapes. Specifically, a “nature conservation module” should be established for organic farming. It should be transparent, easy-to-understand and easy-to-identify for customers (with a logo).

**More information: www.landwirtschaft-artenvielfalt.de**

Such findings have led to widespread discussion in the scientific literature on land “**sharing versus sparing**”. Land sharing basically means integrating biodiversity objectives in agricultural systems (e.g. *sharing* farms) whereas land sparing argues for high-yield farming combined with protecting natural habitats (*sparing* them from conversion to agriculture) (Phalan et al. 2011, Grass et al. 2019). This has direct impacts on the amount of land estimated to be available for agriculture under sustainability criteria in the scientific community. A case could be made that **sharing and sparing relate to the dual goals of biodiversity conservation**: halting loss in general by sparing land *and* maintaining essential ecosystem services by sharing it.

Ninety-one countries submitted reports to the FAO on **the state of their biodiversity for food and agriculture and its management**, focusing particularly on associated biodiversity[11] and its role in the supply of supporting and regulating ecosystem services (FAO 2019). On the one hand, the report found that: “The use of a wide range of management practices and approaches regarded as favourable to the sustainable use and conservation of biodiversity for food and agriculture is reported to be increasing” (FAO 2019). For example, 80% of reporting countries indicated that one or more biodiversity-focused practice were being used in one or more types of production system. On the other hand, the report concluded that: “**Monitoring programmes for biodiversity for food and agriculture remain limited**” (FAO 2019). This was found to be the case even in developed regions with dedicated research projects on the links between biodiversity and food supply. Altogether this implies that existing measures to incorporate and conserve biodiversity are not yet applied at large enough scales to be effective, and/or that they are systematically insufficient to solve the problem. **Bad incentives may also counter efforts**. For example, agricultural support potentially harmful to nature amounted to $100 billion in 2015 in countries belonging to the OECD. Some subsidy reforms (e.g. to reduce unsustainable pesticide uses)

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[10] For instance, the State of Sustainability Initiative estimates a total production value of around USD 50 billion for sustainable commodities in agriculture, forestry and fisheries (Loconto et al. 2016, Potts et al. 2014). The value of the global market for certified organic products was around USD 80 billion in 2014 (Willer and Lernoud 2016).

[11] Defined as “the vast range of organisms that live in and around food and agricultural production systems, sustaining them and contributing to their output” (FAO 2019).

have been introduced and multiple programmes encouraging more sustainable practices exist[12]. Clearly, the need for transformational change spans multiple stakeholders and systems.

Altogether a substantial shift in agricultural practices and expectations is needed. Many see this potential in **regenerative agriculture**. This means shifting agriculture from a major source of degradation to a major source of regeneration (TEEB 2015, Kremen et al. 2015, DeClerck et al. 2016). For example, the agroecological transition framework[13] described what an agroecological transition in Europe might look like, both in terms **of *how* food is produced, but also in *what* foods are produced.** The Economics of Ecosystems and Biodiversity (TEEB) for Food and Agriculture programme[14] promotes systems thinking to take the true cost of the externalities of food on biodiversity into account. The Resilient Food Systems program advances a holistic and integrated approach to enhancing agricultural productivity while safeguarding ecosystem services in smallholder systems in Africa[15].

**Modelling** from science supports the idea that **a transformational shift with positive outcomes on biodiversity is possible**. For example, Kok et al. (2018) found that land use impacts from crop production, grazing and forestry together amounted to almost 60% of total worldwide loss of terrestrial 'Mean Species Abundance' (indicator of biodiversity intactness; see also Section 4.3) up to 2010. Under a business-as-usual scenario species loss would continue in the future, with the largest losses expected in Sub-Saharan Africa. Under three alternative pathway scenarios, biodiversity would still be lost, but the scale of loss would be considerably less. The pathways-- 'global technology pathway' (e.g. land sparing), 'decentralised solution' (e.g. characterised by land sharing) and 'consumption change' (e.g. less meat in particular)—were shown to have different potentials in different places[16]. The study emphasised that increased productivity is key to both pathways, noting that precision techniques may offer range of new opportunities for land sharing and warning that land sparing may not always work because of rebound effects (Ceddia et al. 2014, Hill et al. 2015).

Egli et al. (2018) came to similar conclusions regarding the potential to conserve biodiversity and the importance of regionally differentiated strategies. They integrated distribution and habitat information for almost 20,000 vertebrate species with land-cover and land-use datasets. Their scenario of projected agricultural intensification would reduce the global biodiversity value of agricultural lands by 11% between 2000 and 2040. In contrast, spatial land-use optimisation scenarios reveal that "**88% of projected biodiversity loss could be avoided through globally coordinated land-use planning**, implying huge efficiency gains through international cooperation**".** The study, however, points to the highly uneven distribution of costs and benefits in such a global-scale optimisation. With a lack of governance mechanisms to guarantee equitable compensation of 'losers', multinational land-use optimisation seems politically unlikely. In a scenario based on nationally focused optimisation, 61% of projected biodiversity loss could still be avoided, with 33% through optimisation within just 10 countries. **For companies in the food industry this implies that it is vitally important to monitor not only impacts across supply chains, but to have some indication of the 'big picture' concerning where raw materials are sourced and what can be done to better reconcile future trade-offs between agriculture and conservation.**

Finally, in 2018 around 60 experts in biodiversity and land use modelling joined efforts to **illustrate the potential for innovative modelling techniques** for informing robust science-based targets and

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[12] For example, Incentives for Ecosystem Services are packages of measures that aim to support farmers in the adoption of sustainable agricultural practices that will benefit the environment and improve long-term food security: http://www.fao.org/in-action/incentives-for-ecosystem-services/en/.

[13] The think tank IDDRI developed a radical—yet plausible, coherent and scientifically sound—scenario for an agroecological transition in Europe: https://www.iddri.org/en/project/ten-years-agroecology-europe

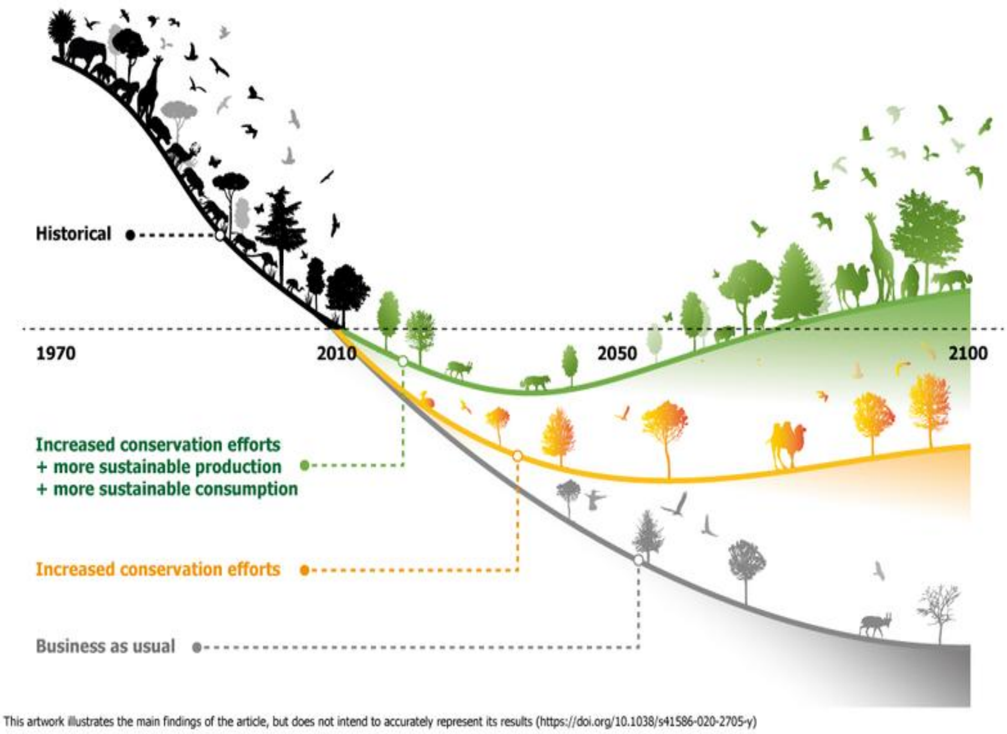
[14] For more information see: http://teebweb.org/our-work/agrifood/

[15] Also ensuring that gender and nutrition are mainstreamed; see also https://www.thegef.org/topics/food-security

[16] Regions where the global technology pathway offer potential include the Congo basis, western part of the USA and mid china. In regions such as South Asia, Eastern Europe and Eastern USA decentralised solutions play a higher role, whereas the Southern part of South America, Turkey and Northern Africa show high potential benefits from both.

conservation planning (Leclère et al. 2018). Four global land-use models and eight global biodiversity models (see the Annex for a description; Table 7.2) were used to illustrate how the biodiversity trend could be bent upwards instead of continuing to decline. Figure 2.1 depicts this in an illustrative way. The study focused on land-use change as it is the biggest current threat to biodiversity. Overall, the study not only marks an important step forward toward mobilising current knowledge from the land-use and terrestrial biodiversity modelling communities, but also demonstrates the current **capacities of the science community for co-developing science-based business tools and monitoring approaches**.

**FIGURE 2.1 BENDING THE CURVE**




Source: Leclère et al. 2018

## 2.3.4. LONG DISTANCE SUPPLY CHAINS DISPLACE IMPACTS FROM CONSUMERS

*"Bold changes to the direct drivers of the deterioration of nature cannot be achieved without transformative change that simultaneously addresses the indirect drivers."* (IPBES 2019)

Roughly 25% to 50% of the environmental impacts from consumption are estimated to be felt in regions other than where the consumption occurs[17] (IPBES 2018a). For instance, 30% of global species threats (Lenzen et al. 2012) and 32% of the consumption of scarce water (Lenzen et al. 2013) have been linked with international trade. Lenzen et al. (2012) calculated a "biodiversity footprint" by looking at trade of "implicated commodities", finding that the USA, Japan and Germany are the top net importers of biodiversity threats. In particular, the consumption of **imported coffee, tea, sugar, textiles, fish and other manufactured items leads to large "biodiversity footprints".** Wilting et al. (2020) also found that agricultural products and food comprised around 50% of land-related impacts on biodiversity from household consumption[18]. They calculated 'land-based biodiversity footprints' in the EU at a sub-national level (162 regions) in 2010, finding that **most regions are already net importers of biodiversity losses**, and that there is a shift from the domestic to foreign part of the biodiversity footprints with rising population density and income. Indeed, for international trade of food and timber products in particular,

[17] This includes e.g. carbon, chemical pollutants, biodiversity loss, and the depletion of freshwater resources

[18] With other categories including e.g. manufacturing, energy, transport and trade, etc.

**there is a growing spatial disconnect between environmental impacts due to production and the places where consumption happens** (Erb et al. 2009). Looking at agriculture specifically, Chaudhary and Kastner (2016) found that 83% of total species loss is due to agriculture for domestic consumption while 17% is due to the production for exports. The study assessed species lost (i.e. species 'committed to extinction') in 804 ecoregions and combined this data with high spatial resolution global maps of crop yields. It found that where crops are sourced is often more important than how much area is imported. This is because crops such as sugarcane, palm oil, rubber and coffee typically occupy biodiversity-rich regions, leading to disproportionately high biodiversity impacts on comparatively small areas. Finally, the study found that **"imports of industrialised nations drive extinctions in tropical, biodiverse nations**" (Chaudhary and Kastner 2016).

At the turn of the 21st century, around 72% of poultry and 55% of pigs were farmed in global industrialised animal-production systems (Galloway et al. 2007). **Animal feed** is often produced in other regions and consumed far from the point of production. Green et al. (2019), for example, linked direct material flows to global financial data to capture both the re-exports of soy and the consumption of soy embedded in other products. The study showed that much of the soy consumed in Europe arrives via ports in the Netherlands[19], from where it is re-exported and fed to e.g. pigs and poultry in Germany. This makes the Netherlands a key player with disproportionate influence on traders and buyers. It is thus **in a position to initiate and drive change**, which could be one reason behind its founding role in e.g. the Amsterdam Declaration[20]. Large corporations, or groups of businesses, may also use their market power for encouraging biodiversity conservation, with the prerequisite that key hotspots and pressures have been identified.

Altogether, Lenzen et al. (2012) concluded that "policy aimed at reducing local threats to species should be designed from a global perspective, taking into account not just the local producers who directly degrade and destroy habitat but also the consumers who benefit from the degradation and destruction." The **consumer responsibility principle**, increasingly acknowledged in the climate change arena, could be further explored for biodiversity and ecosystem services. The challenge is communicating impacts to customers in a transparent, reliable and comparable way. To this end, monitoring can play an increased role in the food industry.

# 3. TARGETS AND CRITERIA

*"Lessons from conservation project management suggest that a systems-based approach, linking indicators to goals in order to answer specific management questions, is most effective for monitoring biodiversity." (IUCN 2020b)*

## 3.1. BIODIVERSITY TARGETS AT DIFFERENT LEVELS OF GOVERNANCE

Nearly all of the world's governments united around the **Convention on Biological Diversity** (CBD) Global Strategic Plan for Biodiversity 2011–2020 and its twenty Aichi Biodiversity Targets[21]. In this context, countries must develop National Biodiversity Strategies and Action Plans. Delivery against a common set of indicators is monitored and reported on a regular basis, with results synthesised globally. However, **none of the Aichi Biodiversity targets will be met.** Some will be partially achieved, for example those

[19] The Netherlands is the largest importer of soy in Europe. It processes around 25% of its soy imports to produce animal feed. It is also the second-largest exporter of agricultural products in the world (van Gelder et al. 2014).

[20] The Amsterdam Declaration is a commitment by seven European countries to eliminate deforestation from agricultural commodity chains. For more information see: https://ad-partnership.org.

[21] With multiple goals to halt loss, safeguard ecosystems and implement changes: https://www.cbd.int/sp/targets/

related to policy responses[22]. The target for protected areas is 17% global cover. Around 15% has been achieved, but this only partly covers important sites for biodiversity and they "are not yet fully ecologically representative, well-connected and effectively or equitably managed" (IPBES 2019). For nearly one-third of the goals, there has been little to no progress towards them or, instead, movement away from them (Addison et al. 2018). The UN developed a new set of goals for the post-2020 period, which shall be adopted in 2021. It is centered around a vision for 2050 of "Living in harmony with nature"[23].

The 17 **Sustainable Development Goals**[24] were adopted by the UN Member States in 2015 as part of the 2030 Agenda for Sustainable Development. They are **an urgent call for action** and were designed to address all of the dimensions of sustainable development – economic, social and environmental – together, recognising that policies for reaching goals need to be based on a **systemic understanding** of the challenges and designed as an integrated, coherent package managing for co-benefits and mitigating the effects of trade-offs.

The recently adopted **EU Biodiversity Strategy for 2030** aims to protect nature and reverse the degradation of ecosystems. It contains commitments to protect at least 30% of the EU's land; manage 25% of agricultural land under organic farming and promote the uptake of agro-ecological practices; and establish biodiversity rich landscape features on at least 10% of farmland by 2030 (European Commission 2020a). The accompanying **Farm to Fork Strategy** aims to move toward a more healthy and sustainable EU food system (European Commission 2020b). It includes over 10 billion EUR to be invested in research and innovation under Horizon Europe and proposes the development of a **sustainable food labelling framework** that covers the nutritional, climate, environmental and social aspects of food products. For business, the Commission will additionally put forward a new initiative in 2021 **on sustainable corporate governance** to help businesses address due diligence across their economic value chains. It will also support building **a European Business for Biodiversity movement** to incentivise the take-up of nature-based solutions[25]. In 2019 the European Commission adopted a Communication to '**Restore the World's Forests**', including aims to reduce the EU consumption footprint on land (European Commission 2019). The European Commission is currently exploring regulatory and non-regulatory options for additional demand side measures to ensure **deforestation-free supply chains**[26]. At the same time, the European Commission has been looking at ways to operationalise a '**No Net Loss**' principle[27]. A guidance on achieving no net loss or net gain of biodiversity and ecosystem services was published in 2020 (Tucker et al. 2020). It covers the avoidance, minimisation, restoration and offsetting of impacts in accordance with the mitigation hierarchy and promotes the inclusion of agriculture, forestry and fishing sectors in 'No Net Loss' policy measures (so far measures have been aimed towards developments in the built environment and extractive industries) (Tucker et al. 2020).

[22] Such as the spatial extent of terrestrial and marine protected areas, the identification and prioritisation of invasive alien species, national biodiversity strategies and action plans, and the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilisation.

[23] For more information see: www.cbd.int/conferences/post2020. For example, the new draft proposes to protect and conserve through a well-connected and effective system of protected areas and other effective area-based conservation measures at least 30% of the planet with the focus on areas particularly important for biodiversity by 2030.

[24] See the goals online at: https://sdgs.un.org/goals

[25] Through e.g. the 'EU Business @ Biodiversity Platform' and taking inspiration from e.g. 'Business for Nature' and 'One Planet Business for Biodiversity'.

[26] The public consultation of the impact assessment ended in December 2020 and Commission adoption is planned for the second quarter of 2021.

[27] This means that damages resulting from human activities need to be balanced by at least equivalent gains. For more on the EU policy strategy see: https://ec.europa.eu/environment/nature/biodiversity/nnl/index_en.htm.

## 3.2. THE SCIENTIFIC DEBATE ON SETTING TARGETS

There is an ongoing debate between those who prioritise conservation strategies (keeping humans out) and those who argue that biodiversity should be rather integrated into managed areas. According to Dinerstein et al. (2017) "protected areas are the cornerstone of **biodiversity conservation**". The 2020 global target of 17% protected land is, however, not a science-based level of protection. Instead, it is "woefully below what the results of most scientific studies show are necessary to meet widespread conservation goals" (Noss et al. 2012). Dinerstein et al. (2017) argue that we need a **"Global Deal for Nature"**. They propose the ambitious goal of 50% protected land. This target has been coined by advocacy and policy papers as "***Nature Needs Half"*** (Locke 2013, Pressey et al. 2003, Noss et al. 2012). While *Nature Needs Half* has also been contested as "impossible", the scientific basis for it has been growing (e.g. Wilson 2016, Willet et al. 2019). It depends critically on how each half would be used—would it empower indigenous peoples and local communities as part of formal protection networks in the half protected, and what would agriculture look like on the other half? Experience has shown that the idea of sparing nature in protected areas only to intensify agricultural production in neighbouring areas is not a viable long-term strategy for conserving biodiversity (see Chapter 2). In part, this is due to the supply and demand forces for both food and non-food crops (like cotton, biofuels, etc.) that increase pressures for more land conversion.

Indeed, while the pivotal role of protected areas is indisputable, the **establishment of protected areas alone is not enough to halt biodiversity loss** (Simmonds and Watson 2018). Complementary targets have been proposed in the scientific literature. For example, Garibaldi et al. (2020), propose a minimum **habitat restoration target for working landscapes** (e.g. farming, ranching and/or forestry) of at least 20%[28]. They recognise the important regulating benefits[29] such landscapes could and must provide. That study also argues that "such restoration can also enhance the effectiveness of protected areas by **offering corridors and stepping stones interconnecting wild populations across landscapes that might otherwise form barriers or sinks**" (Garibaldi et al. 2020). They advocate the 20% target as a minimum, acknowledging that it can also be seen as an aspiration to help guide national and intergovernmental discussions.

DeClerk et al. (2016) argue that because agricultural systems are simultaneously dependent on and providers of ecosystem services, they can be leveraged to support achieving sustainability targets by operationalising ecosystem services and resilience-based interventions in agricultural landscapes. Examples from countries which already surpass half protected—Namibia, Nepal, and Bhutan—make use of core protected areas, as well as buffer zones and connectivity, as part of their national strategies. These aspects are critical for both biodiversity and ecosystem services in agricultural systems.

An important aspect of future land use is whether it could provide all ecosystem functions, including provision of resources for food and feed. Integrated assessment models have outlined the feasibility of sustainable food supply and a stabilisation of global land use patterns (Willet et al. 2019).

"The absence of **scientific targets for achieving healthy diets from sustainable food systems** has been hindering large-scale and coordinated efforts to transform the global food system" (Willet et al. 2019). In 2019, a Commission of prominent world scientists[30] came together to tackle this issue. They defined **scientific targets for the safe operating space of food systems for six key Earth system processes** (Willet

[28] Noting that the 20% minimum needs to be adapted to different contexts: variation exists in the land area needed for nature's different contributions to people and different socioecological contexts.

[29] Such as soil protection and regeneration, water and air purification, pollination, pest control, etc.

[30] Including 19 Commissioners and 18 coauthors from 16 countries in various fields of human health, agriculture, political sciences, and environmental sustainability.

et al. 2019). It would be possible to provide healthy diets[31] for an estimated global population of about 10 billion people by 2050 within their safe space framework. The 6 quantitative targets include the total global amount of cropland available (13 million $km^2$)[32] and biodiversity loss (in terms of extinction rate)[33], as well as targets on water use, greenhouse-gas emissions, nitrogen and phosphorus use that can be due to food production. "These boundaries should be viewed as guides for decision makers on acceptable levels of risk for human health and environmentally sustainable food production" (Willet et al. 2019). As regards their proposed target for cropland, it can be translated to (globally) **zero future land conversion of natural ecosystems into farmland**. This strategy also complies with the biome boundary proposed by Steffen et al. (2015) in the overarching planetary boundaries context. As regards the proposed target for biodiversity loss, Steffen et al. (2015) propose maintaining a biodiversity intactness index of 90%[34]. In addition to stabilising the global extent of major land use types, "**integrating a minimum of 10% of ecologically conserved land at fine scales (less than 1 $km^2$) into agricultural systems enables habitat connectivity… and access to the services biodiversity provides to support food production"** (Willet et al. 2019).

Altogether, there is strong consensus within the scientific community on the *need to halt the further loss of biodiversity*. This implies ***both zero land conversion*** – from near-nature to far-from-nature types of land use - as well as the ***integration of ecosystem services*** into agricultural landscapes. Quantitative, science-based targets have been proposed, which provide a baseline for monitoring and measuring progress.

**BOX 2. THE LOCAL BIODIVERSITY INTACTNESS INDEX: AN EXAMPLE OF SCIENCE-BASED COVERAGE OF GLOBAL DATA ON BIODIVERSITY**

The Local Biodiversity Intactness Index is based on the Predicts database of local biodiversity surveys combined with high resolution global land-use data. The database has collected and combined on-site data from studies that compared terrestrial biodiversity under different intensities of human pressures from over 3.6 million records for over 32,000 sites (in 94 countries) and a taxonomically representative set of over 45,000 plant, invertebrate and vertebrate species. The index provides estimates of human impacts on the intactness of local biodiversity worldwide. It estimates how much of a terrestrial site's original biodiversity remains in the face of human land use and related pressures, and how this may change over time. Data can be averaged and reported for any larger spatial scale (e.g. countries, biodiversity hotspots or biomes).

**More information: www.predicts.org.uk**

## 3.3. DERIVATION OF TARGETS FOR BUSINESS OPERATIONS

"Sustainability in supply chains will need clear and measurable targets, pathways to achieve them, and accountability" (Green et al. 2019). Too often sustainability commitments are, instead, general statements of intent and recognition of the problem. What is needed is **a major shift from "doing a *little less bad* to doing *our fair share*"** (SBTN 2020). This is why the Science Based Targets Network (SBTN) is

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[31] This healthy reference diet largely consists of vegetables, fruits, whole grains, legumes, nuts, and unsaturated oils, includes a low to moderate amount of seafood and poultry, and includes no or a low quantity of red meat, processed meat, added sugar, refined grains, and starchy vegetables. They found with a high level of certainty that the global adoption of the reference dietary pattern would provide major health benefits, on top of environmental ones.

[32] Using minimum forest cover, biodiversity intactness index, and area-based intactness for key biomes as guides for setting the scientific target for land use from food production.

[33] Noting that a high degree of uncertainty exists about the rate of extinctions that the Earth system can tolerate, an uncertainty of 1–80 extinctions per million species per year is suggested, with the lower value (i.e., 1) being equal to the background extinction rate and the upper value (i.e., 80) being agriculture's share of effect on species decline.

[34] This target has been exceeded. Newbold et al. (2016) found widespread transgression of safe limits and estimated that for around 58% of the world's land surface, land use and related pressures have already reduced local biodiversity intactness (using the Local Biodiversity Intactness Index: See Box 2). They conclude that "if the proposed boundaries are broadly correct, ongoing human intervention may be needed to ensure delivery of ecosystem functions across most of the world" (Newbold et al. 2016).

working on a guidance for science-based targets[35] related to the planetary boundaries framework. Their report argues that "**we can't wait for the perfect science**" (SBTN 2020). It covers actions to "avoid future impacts, reduce current impacts, regenerate and restore ecosystems, and transform the systems in which companies are embedded" (SBTN 2020). In this sense it is based on the mitigation hierarchy by the International Financial Corporation's (IFC) Performance Standard 6, which helps companies plan for and address their impacts on biodiversity at a project level. The guidance emphasises a process to 1) *Assess* value chain-wide impacts and dependencies, 2) *Interpret and prioritise* across different spheres of influence, 3) *Measure, set and disclose* by collecting baseline data and setting targets aligned with Earth's limits, 4) *Act* by avoiding, reducing, restoring and transforming, and 5) *track* by monitoring progress. This is similar to many of the processes proposed to help companies monitor and evaluate their biodiversity pressures (see Section 4.2). As regards specific derivation of targets, work is ongoing. The report provides key illustrative and interim targets (Table 3.1).

**TABLE 3.1. INTERIM EXAMPLES OF TARGETS FOR BUSINESS**

| Target | Illustrative target wording | Initital guidance on target ambition for companies | Indicator | Alignment (with corporate reporting, global goals and Earth's limits) |
|---|---|---|---|---|
| Land use change | Reduce to X% by 2030 activities causing deforestation/conversion in your supply chain | • Zero deforestation from 2020 / Zero conversion of natural habitats in value chain by 2030 following Accountability Framework Initiative*<br>• No net loss of non-forest natural habitats from 2020, following IFC Performance Standard 6 | Deforestation / Conversion of natural ecosystems (ha) | • Accountability Framework Initiative; CDP Forests<br>• SDG 15<br>• Planetary boundaries on land use and biosphere integrity |
| Ecosystems | Regenerate ecological integrity in supply chain by ensuring X% ecological focus areas per $km^2$ for all sourced agricultural inputs | 10% biodiversity rich landscape features per $km^2$; following European Commission definitions | Fraction of agricultural land in ecological focus areas at 1 $km^2$ scale (%) | • CBD Post-2020 goal on area; connectivity, and integrity of natural ecosystems; SDG 15<br>• Planetary boundaries on land use and biosphere integrity<br>• European Commission (policy) |
| Species | • Avoid sourcing from areas of high species extinction risk<br>• Reduce by X% extinction threat to species | Ambition guidance coming soon | Species Threat Abatement and Recovery (STAR) | • IFC Performance Standard 6<br>• CBD Post-2020 goal on species extinction SDG 15<br>• Planetary boundaries on biosphere integrity |

Source: adapted from SBTN 2020; see also their "Indicator Crosswalk Framework" available in their technical Annex.
Note: *The Accountability Framework Initiative supports the global effort to produce agricultural and forestry commodities while protecting forests, other ecosystems, and human rights: https://accountability-framework.org

A recent report on 'Planetary boundaries for business' (CISL 2019) also advocates the advantages of taking a planetary boundary perspective: this would help companies to move beyond strictly focusing on solutions related to their single issues toward more meaningful decisions and responses toward restoring a well-functioning planet and triggering **deep change about the role of business today.** The report proposes '**upscaling' the impact of a company on a given location or ecosystem to the planetary boundary level**. This is complementary to the approach of 'downscaling' planetary boundaries from a global scale to regional or local levels (Häyhä et al. 2016). Downscaling can be challenging due to the

[35] Defined as "measurable, actionable, and time-bound objectives, based on the best available science, that allow actors to align with Earth's limits and societal sustainability goals" (SBTN 2020).

interconnected nature and scale of impacts (which are different in different places; i.e. key biodiversity areas). Indeed, the Earth system framework was designed to complement methods that already exist at local and regional levels, not replace them. Downscaling may also lead companies toward a more exploitative mindset. Instead, an upscaling approach may shift the focus toward the need for more regenerative activities (doing good) as opposed to doing "less bad" (e.g. by implementing eco-efficiency gains). "Upscaling is focused on building outwards from a single company's actions and impacts towards the bigger picture of how it influences global processes" (CISL 2019). Such approaches are used by other initiatives, such as climate change (if everyone acted like X, it would mean Y degrees of warming) or by the Global Footprint Network (how many planets would be needed to sustain lifestyles characterised by X?). Indeed, while quantitative targets would help companies innovate toward specific goals, a mindset characterised by upscaling could help companies to find multi-benefit solutions across value chains. **For the food industry this could imply a deep change in how and what kind of food is grown *and sold for* consumption** (e.g. UNEP 2019; Willet et al. 2019).

Both types of top-down and bottom-up scaling approaches may be applied. **Work to operationalise the planetary boundaries approach for decision making and business planning is in full swing** (Clift et al. 2017). Several research groups and companies are working on e.g integrating planetary boundaries into Life-Cycle Analysis approaches (Sim et al. 2016, Björn et al. 2016, Murphy et al. 2016). Smith et al. (2018) assess case studies of mainstreaming international biodiversity goals in the private sector, including examples related to the agriculture sector from Kering and Oyu Tolgoi, IBIS Rice and Rabobank. Clift et al. (2017) focus on developing a range of complementary indicators or tools relevant for strategic company, portfolio and sectoral assessments. They contemplate normative allocation issues concerning what a "safe space" means and consider indicator frameworks for the biodiversity planetary boundary included in previous sections of this report (e.g. see also Newbold et al. 2016, Chaudhary et al. 2015).

Altogether, measurable, quantitative targets could provide *a cause* for companies to rally around. Rockström writes: "I increasingly receive the quest to science from business leaders that w**hat we really need are the 2 degree C equivalents for the planet**" (in the Foreword of CISL 2019). That said, the urgency of the *cause* (halting biodiversity loss) is not in question. "Upscaling" may be a strategy to spark the kind of innovation across food supply chains that is needed now. To this end **unprecedented levels of collaboration are needed to** tackle system-wide problems. Collective action can be scaled up through multi-stakeholder partnerships and public–private initiatives (Lambin et al. 2018, Green et al. 2019).

## 3.4. BUSINESS COMMITMENTS AND IMPLEMENTATION STRATEGIES

"*…the food retail sector* [*is*] *in a privileged position to foster "sustainability by consumption" and to support the protection of biodiversity*." (European Business and Biodiversity Campaign, EBBC 2014)

The question is, what can the food industry, including retail, do to support a shift towards both more sustainable production practices and more sustainable consumption practices? Food retailers are the last link of a globalised supply chain and have an important role to play to protect biodiversity. Willet et al. (2019) describe a ladder of indicative interventions - manageable by industry and governments (and public-private partnerships) - from e.g. providing information to choice editing (Table 3.2). The food industry is not alone in its responsibility, but can take on a frontrunner role in the context of government and civil society initiatives. The role of companies is, in particular, to implement ethical supply chains. The Accountability Framework Initiative argues they can: "Take action toward effective implementation systems, including systems for traceability, certification, supplier management, responsible production, monitoring and verification, and improvements beyond the supply chain" (AFi and CDP 2020). Multiple **voluntary** initiatives[36] are underway to this end. Examples are presented in Chapter 4 and the Annex (see Table 7.3). Commitments are one of the first steps.

[36] The Convention on Biological Diversity (CBD) also lists and describes national and regional business and biodiversity initiatives across the world. It is available at: https://www.cbd.int/business/National_Regional_BB_Initiatives.shtml

**TABLE 3.2. HARD TO SOFT OPTIONS TO PROMOTE HEALTHY AND SUSTAINABLE DIETS**

| Option | Description | Indicative industry role |
|---|---|---|
| Eliminate choice | Channel actions only to the desired end and isolate inappropriate actions | Withdraw inappropriate products, diversify the business |
| Restrict choice | Remove inappropriate choice options | Allocate funding to favor sustainable and healthy products |
| Guide choices through disincentives | Apply charges (or taxes by government) | Use of contracts and conditions to shape supply chains |
| Guide choices through incentives | Use financial reward schemes | Consumer reward schemes |
| Guide choice by changing default policy | Provide better options | Already being pioneers by retailers in their own-label products and by in food service actors through menu planning, reformulation |
| Enable choice | Enable individuals to change behaviour | Focused marketing on only healthy and sustainably produced foods |
| Provide information | Inform or educate the public | Prioritisation of brands which appeal to eat differently |

Source: adapted from Willet et al. (2019)
Note: Indicative government and civil society roles are included in the table in Willet et al. (2019).

**Specific, measurable, and time-bound commitments are an essential element of achieving ethical supply chains and communicating risks, opportunities, and actions**. Such commitments "provide direction and clarity on company goals, enable commitments to be pushed to upstream suppliers, and allow for clear communication of progress" (AFi and CDP 2020). Examples include **'No Net Loss' / 'Net Positive Impact', 'No Deforestation' / 'No Conversion',** and '**No Go products'**. In general, companies are starting to take notice and set such biodiversity commitments[37], but overall uptake remains very limited, even in relation to other corporate environmental commitments (de Silva et al. 2019).

**'No Net Loss'** or 'Net Positive Impact' do not have a universal definition. Conceptually, they build on strategies from development projects to either balance or outweigh negative biodiversity impacts caused by projects. This occurs through compensation measures implemented elsewhere (biodiversity offsets[38]). So far, most 'No Net Loss' commitments have been made by **mining companies[39], followed by the energy and manufacturing sectors**. By 2015, no agriculture or forestry companies had made such commitments. However, the IUCN (2015) had begun an exploration on the potential application of such approaches for the commercial agriculture and forestry sectors. It found that, yes, under certain conditions they could definitely play a role. At the same time, as no definition exists, "goals can vary in

[37] For example the Consumer Goods Forum launched the Forest Positive Coalition, including 17 global consumer brands, retailers and manufacturers with a total market value of USD 1.8 trillion to accelerate systemic efforts to remove deforestation and forest degradation from key commodity supply chains. More information at: https://www.theconsumergoodsforum.com/press_releases/new-consumer-goods-coalition-to-accelerate-systemic-effort-to-remove-deforestation-and-forest-degradation-from-key-commodity-supply-chains/. Further examples of specific commitments from major corporations are listed in Box 5 of Potts et al. (2017).

[38] Biodiversity offsets are defined as: "Measurable conservation outcomes of actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity". (Business and Biodiversity Offsets Programme 2012)

**[39]** Including minerals, metals, aggregates and coal mining.

terms of spatial scales, what biodiversity is included, what constitutes appropriate compensation efforts such as biodiversity offsets in the project region, and over what timeline the goal is achieved" (IUCN 2015). Further trials could bring more guidance and reveal potentials.

**Zero-deforestation commitments** signal a companies´ intention to reduce or eliminate deforestation associated with the commodities that they produce, trade, and/or sell. They can include zero-net, zero-gross, and zero-illegal deforestation, each with different implications for forests (Garrett et al. 2019). In 2019 the Accountability Framework reported that commodity-specific disclosures (most were for timber, followed by palm oil, soy and cattle) on forest-related policies were made by 411 companies (AFi and CDP). **Nearly half of those companies committed to producing or sourcing commodities free of deforestation or ecosystem conversion**[40]. However, most of these commitments were not "fully aligned with the principles of the Accountability Framework in their terminology, use of cutoff dates, or inclusion of time-bound targets" (AFi and CDP 2020). **In practice, these commitments were found to lack consistency in scope, ambition, and terminology**. Some clear challenges were distinguished. For instance, only 8% of the companies indicated that their board had oversight regarding implementation and fulfilment of 'no deforestation' commitments, indicating a lack of high-level leadership within corporations. Only 16% of the companies disclosing on soy were able to trace more than half of their volumes past the country level. On the other hand, more than half of producers, processors, and traders reported engagement with smallholders to some extent in their supply chain. Companies are also making good use of available tools for their monitoring, verification and decision processes. Some of the most frequently mentioned tools included Global Forest Watch[41], SPOTT[42], GRAS (see Box 3), and Trase (see Box 7). The Accountability Framework also provides a resource for companies—it has developed consensus-based definitions and guides companies to develop policies and commitments. Currently, however, **only 8 companies made the "A List,"** receiving an "A" score for their Forests disclosure. Only 12 palm oil and 7 soy commitments were dedicated to zero gross deforestation.

Garrett et al. (2019) developed criteria to assess the effectiveness of zero-deforestation commitments at reducing deforestation. They found that **existing commitments "have the potential to be moderately effective in reducing deforestation within targeted supply chains and regions, but leave substantial room for improvement with regards to achieving global reductions in deforestation**" (Garrett et al. 2019). They applied criteria to evaluate 52 zero-deforestation commitments made by 250 companies identified by Forest 500[43] as having high deforestation risk. The key shortcoming was that **they cover only a small share of the global market,** hampering global impacts. Volumes handled by committed companies are less than 12% of the global market for most commodities (primarily soy, cattle products, and palm oil). Although, palm oil companies with some kind of deforestation policy comprise a majority of the global market (handling 65% of global production), their implementation mechanism (the Roundtable on Sustainable Palm Oil) only covers 20% of oil palm area. Biome-wide implementation is--so far—only achieved in the Brazilian Amazon. Elsewhere implementation mostly occurs through certification programs, which are not adopted by all producers and lack third-party near-real time

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[40] Conversion includes severe degradation or the introduction of management practices that result in substantial and sustained change in the ecosystem's former species composition, structure, or function.

[41] Global Forest Watch is an online platform that provides data and tools for monitoring forests. By harnessing cutting-edge technology it allows anyone to access near real-time information about where and how forests are changing around the world. More information at: https://www.globalforestwatch.org/about/

[42] SPOTT – Sustainability Policy Transparency Toolkit – is a free, online platform supporting sustainable commodity production and trade. It assesses commodity producers, processors and traders on their public disclosure and scores tropical forestry, palm oil and natural rubber companies annually against over 100 sector-specific indicators to benchmark their progress over time.

[43] Forest 500 ranks the most influential companies driving tropical deforestation. Their latest assessment of the 500 biggest companies in these supply chains - and the financial institutions that fund them - found that almost half did not have any commitments to prevent deforestation. See: www.forest500.org.

deforestation monitoring[44]. Moreover, around half of all commitments are for either zero-**net** deforestation (which can lead to a transition towards planted forests with low ecological integrity) and/or **future** implementation deadlines (which allow for pre-emptive clearing). There have also already been several high profile cases of non-compliance by committed companies. Altogether, "**a commitment is only regionally and globally effective if avoided deforestation in the target supply chain is not displaced to other actors, regions, times, or commodities**" (Garrett et al. 2019).

A **"no- go list"** with products or ingredients which may not be sold could be one mechanism employed by food retailers to enforce commitments to e.g. zero deforestation. Such no-go products could include substances of protected/endangered animal or plant species or products on which the production obviously violated nature conservation requirements. "No-go products must not get into the selection" (EBBC 2014).

Altogether, "**all voluntary commitments still have enormous potential for improvement, but at least a start was made"** (EBBC 2014). A note of caution is also needed with regard to enthusiasm for voluntary environmental policies. There is the risk that "they may merely advantage the most powerful companies and reduce the agency of affected local communities by moving control of deforestation activities to market forces" (Garrett et al. 2019). To this end, voluntary initiatives could be used as a testing ground, scaling up mechanisms that can successfully control deforestation to be legally binding. Moreover, the effectiveness of business commitments depends on strengthened public governance capacity in forest risk regions, including reductions in illegal logging and planting, illegal land clearing, timber smuggling, and tax evasion. An example of a public-private partnership is the 'Tropical Forest Alliance[45]' (IUCN 2015). Another option could be a "Zero-deforestation Zone", where companies would commit to sourcing from jurisdictions that have established regional programs to reduce deforestation (Meyer and Miller, 2015). In any case, options exist and require public and private engagement.

**BOX 3. THE GRAS TOOL: SUPPORTING 'SUSTAINABLE, TRANSPARENT & DEFORESTATION-FREE SUPPLY CHAINS'**

The Global Risk Assessment Services (GRAS) project has developed a tool to support companies by calculating a GRAS Risk Index and comparing the sustainability risk for multiple regions of interest. It is based on the four main pillars of biodiversity, land use change, carbon stock and social indices. For example, potential land use change heat maps allow the identification of high-risk areas and indicate which regions are highly affected by unsustainable forest clearings. The overarching project is intended to support the environmentally sound use of resources for a sustainable bioeconomy, specifically through the establishment and monitoring of sustainable and deforestation-free supply chains. Analysis of high-resolution remote sensing data from the latest generation of satellites enables changes in land use to be documented. Regionally, the prototype covers important biomass-producing regions of the world: EU, USA, Canada, Central and South America (selected countries) and Southeast Asia. The development of GRAS is supported by the German Federal Ministry of Food and Agriculture through the Agency for Renewable Resources (FNR).

**More information: www.gras-system.org**

[44] For example, the GLAD alert system devised by the University of Maryland's Global Analysis and Discovery (GLAD) lab uses satellite imagery to collect weekly data on deforestation across the tropics. It indicates when a 30 by 30 meter area has experienced disturbance in the forest canopy using NASA's Landsat satellites to automatically flag areas which have changed in comparison to historical data. More information at: https://glad.geog.umd.edu.

[45] A public–private partnership in which partners take voluntary actions, individually and in combination, to reduce the tropical deforestation associated with the sourcing of commodities such as palm oil, soy, beef, and paper and pulp. The Alliance does so by tackling the drivers of tropical deforestation using a range of market, policy, and communications approaches.

# 4. BIODIVERSITY ACCOUNTING APPROACHES

There has been a **mushrooming of approaches and tools** to support companies in better assessing the biodiversity impacts connected to the production of consumer products. These approaches address different aspects of the challenge depending on multiple factors. For instance, is the company looking at *where to invest* or does it wish to monitor *existing impacts* across its current supply chains? Is the aim to support and track changes to farming practices *on the field* or is it to *avoid indirect impacts* such as pressures related to land use change? Is the aim to disclose to customers the biodiversity performance of (1) specific products along specific supply chains or (2) overarching company performance? All of these questions, and more, have implications as to what approach – or corresponding tool—is **appropriate for companies**.

This paper has grouped approaches into three general categories:

- **Certification and standards** generally rely on third party assessment at the farm level. We review the state of development regarding coverage and effectiveness of criteria with relevance for biodiversity as well as identify challenges for further deployment to effectively contribute to halting biodiversity loss.
- **Business guidelines and tools** describe a process-oriented approach to support companies to monitor their own performance. We look at the current state-of-the-art on how companies are incorporating biodiversity into their accounting, reporting and disclosure processes at various levels of activity.
- **Biodiversity footprints** describe a single, quantitative metric that could be used as a "headline indicator" at multiple scales (product, company, sector or country). We assess the role such indicators could play, review the types of approaches used (life-cycle analysis, input-output, modelling) and present examples from business and science-related applications.

**These approaches are complementary.** There is also overlap of those "categories" as certification and footprints may be applied in the context of business guidelines. This grouping is not meant to be exclusive or exhaustive, but rather to provide a basis for assessing the broad scope of activities in general. It is a starting point for further exchange, knowledge sharing and innovation.

**BOX 4. GEOFOOTPRINT: AN EXAMPLE OF A TOOL UNDER DEVELOPMENT THAT INTEGRATES MULTIPLE DATA SOURCES TO PROVIDE A USER-FRIENDLY INTERFACE**

GeoFootprint is a multi-stakeholder initiative launched by Quantis in 2018 with the aim to merge GIS technology (i.e. satellite imagery) and the life-cycle assessment framework into a public web-based platform (including both open access and licensed services for paying customers). It intends to go live in 2021 and aims to provide transparent and granular information on the environmental footprint of crop production including farm and upstream activities, displayed though a broad choice of maps and environmental metrics. At the heart of geoFootprint is a repository of publicly-available geospatial data, as well as metrics from the World Food Life-Cycle Assessment Database, Cool Farm Tool and state-of-the-art agricultural emission models.

**More information: www.geofootprint.com**

## 4.1. CERTIFICATION AND STANDARDS

A buyer for a given product group is not an expert on biodiversity because it is not their core business. That buyer needs assistance or **guidance to identify which products hold risks for biodiversity** and which have been produced using practices aligned with preserving biodiversity and ecosystem services on and beyond the farm. To this end, standards could play a major role. Currently, however, there is not a comprehensive biodiversity label and numerous standards from the food industry consider this field of action in very different ways. There is also limited evidence on their effectiveness overall for conserving biodiversity and halting deforestation.

In general, standards are sets of social, environmental, and/or economic criteria by which producers and companies demonstrate that their performance meets best practice norms in primary production, processing, trading, and consumption of goods. Standards are typically adopted voluntarily and paired with compliance verification, traceability systems[46], and labels to differentiate preferable products in the marketplace. They may be applied in a business-to-business context (e.g. Global G.A.P.[47] or the Roundtable on Sustainable Palm Oil[48]) or directed at the final consumer (e.g. Fairtrade[49] or organic agriculture standards). Characteristic of verification is that auditors assess social and environmental practices and/or performance through **on-site inspection, interviews, farm records, and other corroborating information**. One of the main goals of environmental advocates was to establish certification as a voluntary mechanism that would fill critical gaps in international environmental governance (Steering Committee 2012). Indeed, **certification has achieved substantial and growing market penetration**, and it has garnered widespread and mainstream customer recognition in developed markets. Standards and practices that utilise third-party verification are mostly designed by NGOs, scientists and environmentalists alongside industry actors (IPBES 2019). This brings both benefits (e.g. knowledge on the state-of-the-art) as well as challenges (e.g. regarding stringency and the ambition for deep change versus incremental steps).

Environmental certification exists for a wide range of product and product lines[50]. Most notably, **cocoa, palm oil, tea and capture fisheries can now credibly claim to certify around one-tenth of global production** (van der Ven et al. 2018). Certified area for forests and marine schemes has increased greatly since 2000 (IPBES 2019). However, despite the proliferation of standards in general, criteria for biodiversity remains weak. For example in 2017, Di Fonzo and Hime (2017) reported that the Ecolabel Index[51] **identifies 465 certification schemes across 199 countries and 25 industry sectors, of which only 10 specifically mention biodiversity**.

**Looking more specifically at the food industry, biodiversity is a rapidly growing and more prominent component of standards for major high-impact crops, but coverage of total agricultural land remains almost miniscule.** For example, 'The State of Sustainability Initiatives' on Standards and Biodiversity reviewed 15 major international standard initiatives[52] operating in the banana, cocoa, coffee, cotton, palm oil, soy, sugar, tea and cereals (rice, maize and wheat) sectors (Potts et al. 2017). Across these sectors commodity production compliant with one or more of the standards covered grew by 35% per annum between 2008 and 2014 (Figure 4.1). In 2015 they reached an estimated trade value of USD 52.5 billion. In comparison, the average growth of conventional production over the same period was 3%. In the 8 sectors where standards are most active (see Figure 4.1—this excludes cereals) the total area covered by standards reached 14.5 million hectares in 2014, **accounting for less than 1% of global agricultural area**. Even if certification covered 100% of these 8 agricultural commodities (which make

[46] Traceability systems (chain-of-custody) track certified products from origin to point-of-sale.

[47] Global G.A.P. (good agricultural practices) is a global trademark and set of standards for the certification of agricultural products with the objective of safe, sustainable agriculture worldwide. More information: https://www.globalgap.org

[48] A not-for-profit that unites stakeholders to develop and implement global standards for sustainable palm oil. The RSPO has more than 4,000 members committed to producing, sourcing, and/or using sustainable palm oil. For more information see: https://rspo.org

[49] Fairtrade Standards are designed to support the sustainable development of small producer organizations and agricultural workers in developing countries. Over 1.7 million farmers and workers were involved in Fairtrade in 72 producing countries, with more than 35,000 products available to shoppers sold in 145 different countries in 2019. More information is available online: https://www.fairtrade.net

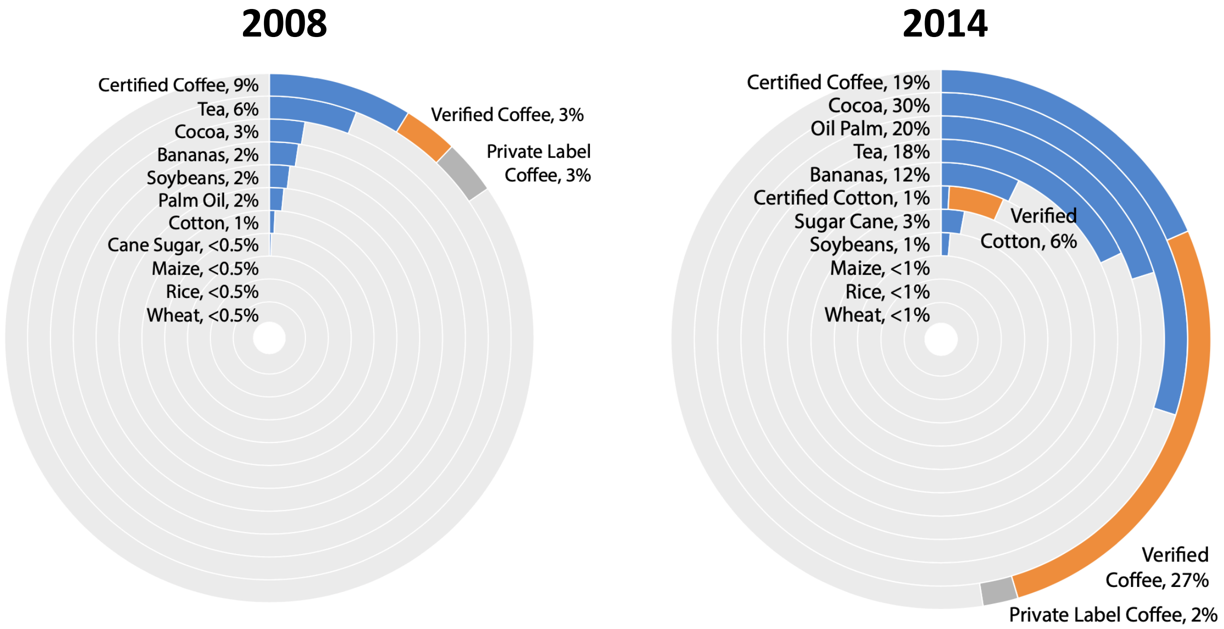
[50] Also see the Standards Map: an online tool to review and analyse more than 260 sustainability standards: www.standardsmap.org.

[51] http://www.ecolabelindex.com/

[52] Fairtrade International, Rainforest Alliance ,Ethical Tea Partnership, Global Coffee Platform (formerly 4C) UTZ Certified, IFOAM (organic), Proterra, Roundtable on Responsible Soy Roundtable on Sustainable Palm Oil Bonsucro, Better Cotton Initiative, Cotton Made in Africa, GlobalGAP, Roundtable for Sustainable Biomaterials.

up the vast majority of certified product growth), only 12% of global agricultural land area would be covered. "If voluntary standards are to play a major role in reducing the impacts of agriculture on biodiversity loss, they will have to, at a minimum, **establish a significant presence among other crops—most notably, staple crops such as wheat, maize and rice"** (Potts et al. 2017). As regards land use change, the review found a clear emphasis on requirements directed toward habitat conservation. For example, 87% prohibited production on land recently converted from some or all types of forests and 7 of the top 10 requirements targeted habitat conservation.

**FIGURE 4.1 STANDARD COMPLIANT PRODUCTION FOR SELECTED CROPS AS A PERCENTAGE OF GLOBAL TOTAL IN 2008 AND 2014**




Source: Potts et al 2017

Note: Adjusted for multiple certification based on directly analysing markets with a combination of FAOstat data, internal market survey carried out with standards bodies in collaboration with the International Trade Centre and Research Institute of Organic Agriculture

A review of biodiversity in the standards and labels of the food sector came to similar conclusions, finding also that **so far biodiversity criteria is, in general, weak.** The study screened 54 standards[53] and company requirements, covering all different types of standards and the most relevant global commodities for the European food market (LCF et al. 2017a). They found some key examples of best practice, but also highlighted considerable gaps across standard and label schemes in general. For example, most of the standards do not include criteria addressing biodiversity **beyond the immediate limits of the farm or company**. Moreover, **in most standards the determination of the starting point (baseline) is not required**. A baseline is key to monitoring and assessing the impact of changed practices. It is also needed for the implementation and development of biodiversity action plans. Finally, although precise criteria and supply chain measures have been developed, there is a **significant gap between the content 'on paper' and their implementation in practice**. Active support for farmers who are responsible for implementing the measures is needed (e.g. training, regular visits, working groups, feedback channels, etc.).

The screening (LCF et al. 2017a) revealed **a total number of 1263 criteria with relevance to biodiversity used by existing standards and labels**. Examples of criteria include e.g. "*protection of primary and semi-natural habitats and protected areas*" or "*restrictions on land use changes"*. As regards the later, it was found that 18% of the international standards reviewed had criteria focused on this. Two examples from

[53] Noting that there are more than 400 standards with relevance for the European market.

standard organisations stand out. First, the Roundtable on Sustainable Palm Oil (RSPO) has criteria that: "*There shall be evidence that no new plantings have replaced primary forest, or any area required to maintain or enhance one or more High Conservation Values (HCVs), since November 2005. New plantings shall be planned and managed to best ensure the HCVs identified are maintained and/or enhanced*"[54]. Second, UTZ[55] states: "*No production or processing occurs in or within 2 km of a protected area unless it is allowed under a management plan of the area*"[56].

In 2020 the World Wide Fund for Nature (WWF) initiated a dialog over criteria for the certification of agricultural crops. The project aimed to provide an orientation on the status quo regarding criteria and assess, together with relevant stakeholders, criteria they think should be part of a minimum baseline. This was compared to current coverage in 29 standards[57]. Biodiversity and land use change were explicitly targeted as key areas. It was found, for instance that between 74 and 83% of invited stakeholders agreed that "Producers must regularly monitor their impact on biodiversity and adjust their management practices as necessary for improvement". However, only 48% of the standards assessed included such a criteria. This tendency toward higher levels of agreement concerning what should constitute a minimum baseline compared to current coverage could be seen throughout most of the criteria relevant for biodiversity and land use change. Interestingly, under 15% of stakeholders agreed that "Producers must make a public commitment to refrain from deforestation/habitat conversion", whereas 21% of the standards required this (WWF 2020). Such examples demonstrate that the challenge is not only developing criteria, but also **mainstreaming and achieving acceptance in the food industry and among stakeholders.**

A further and critical gap of standards and labels in general is **uncertainty on their effectiveness for conserving biodiversity and halting land use change**. In other words, standards focus on production practices, but do not measure the outputs or impacts of changed practices on biodiversity in the environment (Dankers and Liu 2003). Tscharntke et al. (2015) addressed this question using a case study of coffee and cocoa. Certification of these crops has seen a rapid uptake in recent years, moving certified products well beyond their previous niche market status (Millard 2011). Potts et al. (2014) report that 38% of global production for coffee and 22% of global production for cocoa use some form of certification scheme (including schemes that are not principally focused on biodiversity). However, Tscharntke et al. (2015) found scant direct evidence of conservation effectiveness in their review of specific studies. They point out a key **spatial scale mismatch**. This is the „incongruence between the scale at which farm management typically occurs and the scale at which key desired benefits are delivered" (Tscharntke et al. 2015, based on Edwards and Laurance 2012, Fremier et al. 2013). For example, certification generally occurs at the unit of a single plantation or a group of smallholder farmers, but these are not necessarily connected to one another. This may **limit benefits for landscape processes such as biological connectivity, watershed functions, and other ecosystem services**. Tscharntke et al. (2015) suggest two ways to address this challenge: (1) linking existing certification

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[54] Please note: RSPO has elaborated guidance on how to implement this criteria and has developed a 'remediation and compensation procedure' for non-compliant land clearance which occurred since November 2005. Instead of imposing immediate sanctions the aim is to provide a mechanism for the restoration of cleared HCV areas and, if applicable, the compensation of lost conservation values. . More information at: https://rspo.org/certification/remediation-and-compensation.

[55] UTZ is a certification program for sustainable farming of coffee, tea, cocoa and hazelnuts. The program is part of the Rainforest Alliance, an international non-profit organisation. More information at: https://utz.org/what-we-offer/certification/the-standard/

[56] Management plans must be approved by a relevant national or regional authority and include at least the following: (a) identification of the boundaries of areas accessible for production and processing and communication of such to group members, and a ban on further conversion and new land clearing outside of this area; (b) specific actions to mitigate or compensate for impacts on the environment, such as: reforestation, adoption of agroforestry practices, establishment of biological corridors, and clearly defined roles for supervision and implementation of the plan, and time frames. If a management plan is not yet available, the Internal Monitoring System engages with local authorities to develop one.

[57] The project looked at 29 standards relevant for the German market, including dedicated sustainability standards—such as organic and regional labels—but also included standards that were not necessarily considered sustainability standards in the narrower sense.

mechanisms with broader landscape approaches (Sayer et al. 2013, Milder et al. 2014) and (2) adapting certification models to consider the landscape itself as the certified unit (Ghazoul et al. 2009).

Van der Ven et al. (2018) assessed whether eco-labels prevent deforestation, finding that it is highly plausible that certification system and **eco-labels have "neither abetted, nor hindered, the conversion of forested land to agricultural production"** (van der Ven et al. 2018). Their study is based on the assessment of three case studies: the Roundtable on Responsible Soy (RTRS) in Brazil, the Roundtable on Sustainable Palm Oil (RSPO) in Indonesia, and UTZ Certified cocoa in Côte d'Ivoire. They found that between 2011 and 2015 certified production area increased by 440% in Brazil (to cover around 1% of total Brazilian soy production), 163% in Indonesia (to cover around 16% of total Indonesian palm oil production) and 399% in Côte d'Ivoire (to cover around 26% of total cocoa production in Côte d'Ivoire)[58]. At the same time, the rate of change in forest cover is worsening in Indonesia and continues in Côte d'Ivoire and Brazil. They found **strong evidence that coverage was insufficient to impact change** and pointed to discouraging trends regarding a slow-down of certification in the future. An increase in 'South-South' trade may also slow coverage expansion due to lower levels of demand for higher-priced goods with environmental certification. For example, around 12% of global banana production is certified, yet this constitutes more than 65% of globally traded bananas, suggesting that a slow down in certification growth may be quickly approaching (Potts et al. 2017). As regards Brazilian soy, rising demand from emerging economies—for soy as animal feed—is displacing demand from European countries with more stringent environmental sourcing commitments (Schleifer 2017, WWF 2016). Altogether, van der Ven et al. (2018) found the lack of market uptake and, to a lesser extent, the existence of significant loopholes in the content and enforcement of criteria, to be plausible causes for the mismatch between greater certification and deforestation effects. Simply put, **certification systems "are too sparsely used, weakly worded, and poorly enforced to reverse broader patterns of deforestation** that plague agricultural commodity-driven economies" (van der Ven et al. 2018).

Further key challenges for certification regarding biodiversity include:

- **Avoiding marginalisation of smaller producers**. Standards developed for large-scale producers may be difficult to apply within small-scale or developing contexts (Foley and McCay 2014, González and Nigh 2005). For example, requirements may be harder for small-scale producers or costs could be higher (Blackman and Rivera 2011, Lyngbaek et al. 2001, Oosterveer et al. 2014). To address this challenge, political or social support has been provided in some cases (Quaedvlieg et al. 2014). Group certifications — i.e. certifying a cooperative of smallholder producers — is also a common approach. For example, implementation of Biodiversity Action Plans may occur at a cooperative level instead of for every single smallholder (LCF et al. 2017b). Food security of smallholder and subsistence farmers is a related challenge. To this end initiatives such as the 'Food Security Standard'[59] are under development.
- **Taking highly variable conditions into account while harmonising monitoring approaches.** In other words, developing core generic standards and approaches to apply these in the different conditions under which crops are produced around the world (Tscharntke et al. 2015). For example, joint efforts to further develop and implement a 'basic set of biodiversity criteria' are underway (see Box 5). A joint Biodiversity Monitoring System—for example maintained by a sector initiative--would allow actors of the food sector to collaborate in order to achieve positive impacts in a faster and more cost-effective way (LCF et al. 2017b).
- I**ncreasing rigour, transparency, accessibility and uptake**. The availability of multiple and competing schemes may drive down the stringency of standards in a race-to-the-bottom to

[58] Soy, palm oil and cocoa production occupy between 11 to 13 % of total agricultural area in each country.

[59] The project adds an additional module to existing sustainability certification schemes that covers food security criteria in agricultural production. It Is being tested on the ground in Africa, Asia, and Latin America. See also: https://www.welthungerhilfe.org/landingpages-en/food-security-standard-project/

attract more customers (Mutersbaugh 2005, Taylor 2005). For example, there is evidence of '**Forum shopping'** in the Indonesian palm oil sector, where producers have supported the less demanding Indonesian Sustainable Palm Oil (ISPO) instead of the more stringent RSPO certification (Anderson et al. 2016). A proliferation of standards may also lead to confusion by customers and a loss of faith in the standards process (greenwashing)[60]. Agreed minimal criteria (e.g. WWWF 2020; LCF et al. 2017b) could help to establish a baseline in this sense.

- **Improving verifiability and enforcement**. Auditors are experts in assessing the quality of processes, but may not have expertise on evaluating biodiversity. Standards that require processes and methods for the management of biodiversity that fit into verification frameworks (i.e. measurable objectives and results) may be more effective. This includes, in particular, the identification of a baseline. It means, in practice, focusing on the "potential created for biodiversity"[61]. It implies, however, that additional measures are needed to assess effectiveness for conserving biodiversity and learning from what has and has not worked.
- **Avoiding corruption and mitigating conflicts-of-interests. Loopholes** remain a persistent challenge when interests diverge. For example, subsidiary companies may be used to deforest land or deforestation may occur immediately prior to cut-off dates. **Partial certification** allows companies to report on their sustainability credentials (with benefits for their reputation), while only actually changing practices on a portion of their operations. Putting a stop to such practices requires industry-wide consensus. Enforcement efforts to tackle corruption could integrate remote sensing and GIS data to monitor compliance with land conversion criteria in real time (van der Ven et al. 2018).

Altogether, standards can and will likely continue to play an important role to address site specific management practices. A number of initiatives are underway to provide support and address challenges (see e.g. Box 5). For example, the Convention on Biological Diversity has begun an initiative to develop a **core set of commodity impact indicators for agricultural commodity production** (see Table 7.4 in the Annex). Their aim is to support policy makers as well as standard organisations to integrate biodiversity impact monitoring and guide best practices toward reducing the major impacts of key agricultural commodities on biodiversity (Loh 2015).

**BOX 5. BIODIVERSITY IN STANDARDS AND LABELS FOR THE FOOD INDUSTRY: A STRONG RESOURCE FOR EUROPEAN COMPANIES**

This European wide initiative is supported by the EU LIFE program and directed at standard setting organisations and companies with individual sourcing requirements. It aims specifically to improve the biodiversity performance of the food industry. Measures include:

- support and motivation to include biodiversity criteria in standards and company sourcing guidelines (e.g. through "**Recommendations for effective criteria**" and the '**Biodiversity Performance Too**l')
- provide training for farm advisors and standard certifiers as well as persons in companies responsible for the purchase of commodities and product quality
- implementing **a joint monitoring system** for biodiversity used by all standards and food companies.
- close communication and the dissemination of results to the food sector in particular through the creation of a European initiative on '**Biodiversity Performance in the Food Sector'**
- Pilot projects and hotspot analysis (so far covering arable crops, fruit and vegetable production, dairy and meat production).

**More information: https://www.business-biodiversity.eu/en/food-standards**

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[60] To this end, customers may assess and evaluate labels themselves (e.g. with tools like: www.labelonline.de).

[61] For example through the creation, preservation or improvement of habitats. Integrated pest management is also key, in particular as regards the use of pesticides (see LCF et al. (2017b) for more specific recommendations).

## 4.2. BUSINESS GUIDELINES AND TOOLS

"Corporate reporting is a powerful tool for understanding and communicating a company's value creation process and highlighting emerging risks and opportunities" (WBCSD 2019). **Internal accounting and monitoring** of biodiversity performance helps companies to **identify** their key impacts and **take action** to improve their performance. It also enables companies to improve **transparency** regarding their impacts and to **report their achievements** to both shareholders and customers. However, **biodiversity accounting and reporting remain extremely limited**. The challenge of scaling-up successful approaches has been well-recognised by both the scientific and business communities. Multiple resources are now available for business[62] and examples of these are included in the Annex: key platforms, campaigns, partnerships and initiatives are listed and described in Table 7.3 with tools described in Tables 7.5, 7.6 and 7.7 (although not exhaustive, these tables provide an overview of the scope of activity within the field and are excellent places to start).

Despite the recent massive proliferation of biodiversity-focused monitoring strategies for business, "**accounting studies suggest that corporate biodiversity accountability is very much in its infancy**" (Addison et al. 2018b). For example, Addison et al. (2018a) assessed the sustainability reports of the top 100 of the 2016 Fortune 500 Global companies[63]. They used the Global Reporting Initiative sustainability disclosure database, in which 86 of the Fortune 100 companies had publicly available sustainability reports. They found, however, that **only 5 businesses had commitments regarding biodiversity that could be classified as specific, measurable, and time bound**[64]. These mostly referred to commodities. Commitments, such as "No net loss", were missing. Biodiversity was not completely absent; almost half (49) of the Fortune 100 companies mentioned biodiversity or related terms (such as sustainable fishing) in the context of **predominantly qualitative narratives**[65] **.** However, "the lack of standardised quantitative performance indicators creates challenges for comparing performance both between companies and for individual companies through time" (Addison et al. 2018a).

Indeed, "in recent years, there have been calls by several organisations and coalitions for greater alignment and harmonisation in sustainability reporting" (WBSCD 2019). While businesses are already reporting on their environmental performance within a variety of reporting schemes (e.g. EMAS[66] and ISO 14001[67]), these are often based on providing transparency rather than detailed measurement and monitoring of impacts. This is thought to be one of the reasons that Sustainable Development Goals (SDGs) 14 ('life under water') and 15 ('life on land') are the **least well reported of the SDGs by companies.** In other words, there is a perceived lack of indicators to enable that reporting (Lammerant et al. 2019). In a review of how businesses measure their impacts on nature, one study found that **many businesses "are not robustly assessing biodiversity and soil**" (Di Fonzo and Hime 2017). They recommend that "impact metrics should follow a set of principles to be meaningful; measurable and comparable; possible to aggregate; practical; easily accessible; replicable and credible; take into account

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[62] Additionally, the Business and Biodiversity platform and Aligning Biodiversity Measures for Business initiative are developing a decision tree to help companies find an appropriate tool for their needs (see Lammerant et al. 2019).

[63] With a total revenue of US$ 12.6 trillion, dominated by the financial sector, followed by the energy sector.

[64] Walmart, Hewlett Packard, AXA, Nestlé, and Carrefour.

[65] By comparison, in 2015, 80% of the world's largest 250 companies have made science-based climate commitments and disclosed information about carbon emission reductions in their sustainability reports (KPMG 2015).

[66] The EU Eco-Management and Audit Scheme (EMAS) is used by companies and organisations to evaluate, report and improve their environmental performance (see https://ec.europa.eu/environment/emas/). The new regulation (European Commission 2018) includes "land use with regard to biodiversity" as one of 6 core indicators for which organisations are basically required to report. Specifically, companies shall report on the forms of land use with regard to biodiversity expressed in units of area (e.g. ha) for: total use of land; total sealed area; total nature-oriented area on site; and total nature-oriented area off site. These indicators shall enable comparisons over time (reported annually) as well as across sectors, countries and regions (European Commission 2018).

[67] ISO14001 is an environmental management system. It includes biodiversity in a general way (e.g. in a note on the definition of the term 'environment', in a note on the potential aspects of environmental policy, and twice in the annex). The increasing number of references indicate an increasing relevance (Hammerl and Hörman 2016).

local context; be responsive to changes in business practices; and drive business decisions“ (Di Fonzo and Hime 2017).

Biodiversity monitoring is complex. There are a multitude of species and habitats, each with their own sensitivity to different pressure categories, on top of a complicated cause–impact relationship (Lammerant 2018). At the same time, the conservation science community has been developing systems to monitor, evaluate and report on biodiversity outcomes from conservation activities for a long time. “A range of frameworks for, and approaches to, biodiversity indicator development have been developed and used by governments and civil society groups. **Much of this science has not reached the business world”** (Addison et al. 2018b). Nonetheless, there are many valuable lessons from such experiences. For example, Addison et al (2018b) aim to help businesses navigate the selection or development of indicators by putting them into the context of where they could be relevant for business activities. They introduce an **overarching process, designed to help business “know where to start, by asking the right questions upfront and seeking out existing indicators that could help measure and track their biodiversity performance”.** This process is outlined in Table 4.1. It has many similarities with business decision-making frameworks[68], environmental management systems, and the Natural Capital Protocol. These all emphasise that **indicators should always be built into larger management processes**, with the initial scoping phases (see steps 1 and 2 in Table 4.1) being critical for indicator development. A range of approaches (e.g., tools, modelling approaches, etc) from conservation science can help business progress through each step[69]. Overall, biodiversity indicators should be both responsive to, and meaningful for, the business application.

**TABLE 4.1 AN OVERARCHING PROCESS TO HELP BUSINESSES MEASURE THEIR BIODIVERSITY PERFORMANCE**

| Step in the process | Description of the step |
|---|---|
| 1. Define the decision context | • Define all elements of the business application for biodiversity indicators (i.e. Why? What? When? For who? How often? How detailed?). What are the direct and indirect impacts the business has on biodiversity across multiple levels? |
| 2. Set management objectives | • Set clear objectives that relate to what the business wants to achieve and how that can be measured (set monitoring objectives that link to management objectives)<br>• The objectives should align with corporate biodiversity commitments (which may be voluntary, regulatory or could relate to international biodiversity goals) |
| 3. Explore and set management actions | • Explore and prioritise management actions that could be implemented to help achieve management objectives |
| 4. Develop or select indicators | • Select existing indicators, or develop new indicators, that will help measure whether management or monitoring objectives are being achieved, which take into consideration an understanding of the natural system, and uncertainty in how the system will respond to management |
| 5. Conduct monitoring, assessment and reporting | • Begin monitoring, assessment and reporting to meet the decision context requirements<br>• Assess whether management and monitoring objectives are being achieved<br>• Ensure an information management system is in place to ensure the quality control and accessibility of data collected |
| 6. Adapt and refine | • As new information is revealed about the system, adapt management and/or monitoring as required, |

Source: Adapted from Addison et al. 2018b

[68] Like the Plan-Do-Check-Act process to guide the control and continual improvement of business processes (BSI 2015)

[69] The report (Addison et al. 2018b) outlines these in tables and boxes, providing a strong resource for getting started.

In 2020 the IUCN developed "**Guidelines for planning and monitoring corporate biodiversity performance**" (IUCN 2020b). They also describe a **process** for companies to implement internally. Key is both the **Pressures-State-Response framework**[70] for assessing biodiversity, and the need to develop **dashboards** to help companies monitor their own performance across supply chains. The ultimate aim is to use **scalable linked indicators** to measure a company's biodiversity performance and support internal decision making and external disclosure. The use of scalable goals and indicators makes it possible to assess performance across multiple levels (from sites to supply chains to areas of operation) while also enabling aggregation at the corporate level for communication purposes. Examples of scalable indicators include "number of species" or "area under sustainable production". These can be calculated and also aggregated also to landscape, national, regional and global levels. The IUCN guidelines define the ideal number of indicators as "the minimum number that answers the question: **Has the goal or objective been achieved**?" (based on the World Bank 2004). This has two implications. First, **dashboards may be useful for reporting.** Second, setting corporate biodiversity goals are crucial to the monitoring process. Indeed, a clear, pre-defined reference is needed to measure biodiversity performance.

A number of **tools** are available to help business develop indicators for building up their dashboards. Lammerant et al. (2018; 2019) review biodiversity accounting approaches for businesses and financial institutions. The reviews are considered works-in-progress with continuous updates by the EU Business @ Biodiversity Platform[71] with content inspired by joint work of the Aligning Biodiversity Measures for Business Initiative[72]. The main objectives of the first edition (Lammerant 2018) were to provide an overview of different methodological approaches, compare their key features and identify the key obstacles faced by different approaches. The updated version (Lammerant et al. 2019) moves towards identifying common ground amongst multiple approaches in order to converge rather than further distinguish them. Both reviews focus on biodiversity accounting approaches which rely on **quantitative indicators**. In this way, they provide ways to measure state and/or condition so that companies can assess the **scale of their impacts on biodiversit**y. This has been the critical piece of information missing from current corporate biodiversity disclosures and may provide the prerequisite for calculating upstream impacts of their production by indicators such as footprints. Indeed, some of the approaches reviewed are relevant to calculating footprints (see below), but are considered here in the overarching context of available tools for comparative purposes. Other forms of useful assessment approaches (serving complementary business needs) not assessed by Lammerant et al. (2018; 2019) include e.g. checklist-based approaches[73] (such as the European Biodiversity Standard or the Biodiversity Check), Environmental Impact Assessment approaches (which focus on a specific development in a specific area), or approaches to calculate biodiversity offsets (such as the BBOP biodiversity metrics and the Dutch 'Natuurpunten' method). The list and short description of all 14 tools/approaches reviewed by Lammerant et al. (2019) are presented in the Annex of this report (Table 7.5). Overarching key findings of the comparative analysis revealed that:

- Linking biodiversity measurement approaches (and related indicators) to **business applications**[74]

[70] Development agencies have been using the pressure-state-response model to monitor biodiversity for many years, usually with the addition of 'benefits' to become a Pressure-State-Response-Benefit indicator framework (e.g. recommended by the UN to monitor the Sustainable Development Goals and the Aichi Targets).

[71] The EU Business @ Biodiversity Platform provides a unique forum for dialogue and policy interface to discuss the links between business and biodiversity at the EU level. It was set up by the European Commission with the aim to work with and help businesses integrate natural capital and biodiversity considerations into business practices. More information: https://ec.europa.eu/environment/biodiversity/business/index_en.htm

[72] Which aims to achieve common ground between biodiversity tools for business as part of the UN Environment Programme - World Conservation Monitoring Centre.

[73] Which rely on 'yes/no' questions to provide qualitative insights on the level of actions undertaken by a company in the field of biodiversity. They rely on 'implementation indicators' (e.g. 'Do you have a biodiversity action plan?') rather than 'impact indicators'.

[74] One concept of 'business applications' in a natural capital context is introduced in the Natural Capital Protocol. It is defined as "the intended use of the results of your natural capital assessment, to help inform decision making". It provides examples of the types of strategic or operational decisions that could be informed by different applications. More information at: https://naturalcapitalcoalition.org/natural-capital-protocol/.

is key. Lammerant et al. (2019) distinguishes eight different business applications (including aims like assessment of current biodiversity performance, assessment of future biodiversity performance, tracking progress to targets, comparing options, etc).

- Most approaches are **under development**; many are making use of a trial phase to become operational, and, while many are applicable across multiple sectors, exceptions include the Agrobiodiversity Index[75] (applicable to the agri-food sector). The 'Healthy Ecosystem Metric' is under development by the Natural Capital Impact Group and aims to account for land use impacts with subcategories on biodiversity, soil and water (Di Fonzo and Cranston 2017)
- "Not all measurement approaches are designed for **disclosure"**. At the same time there is a strong tendency for more harmonisation and standardisation of reporting allowing investors and other stakeholders to compare biodiversity performance of companies. An example for improving disclosure is the Biological Diversity Protocol[76].
- **Common "metrics"** include 'mean species abundance' and 'potentially disappeared fraction of species' (see the footprints Section below for more information). The 'risk of extinction' (e.g. IUCN Red List) is also frequently used by companies to monitor their impacts, as well aggregate indexes derived from multiple indicators. For example, the 'biodiversity impact index' is used by LIFE Key for certification[77]. The different metrics and aggregation approaches meet different needs and answer different questions. They also may integrate the issue of time differently (e.g. annual indicators with time factored in), with needs for clarity for both users and in relation to targets (integrating time in a comparative way).
- Definitions and the terminology used to describe transparent value chain boundaries, site level impact boundaries and baselines vary between different measurement approaches and in some cases are not clear. **These methodological differences are, however, crucial to the robustness, accuracy and interpretation of monitoring approaches**.

For example**, "Site-based methodologies will give different results depending on how the boundaries around the assessment are drawn" (Lammerant et al. 2019)**. Some approaches, e.g. LIFE Key use different assessment boundaries for negative and positive impacts[78]. **There is also evidence that the baseline determined on-site changes whether targets such as 'No Net Loss' are met**, even under identical conditions. This is because the baseline is used as a measuring stick for tracking progress. At least four types of baselines can be considered: (a) State prior to the implementation of the project; (b) Current state of biodiversity; (c) Counterfactual scenario in which impacts are described relative to a plausible alternative state; (d) State at an arbitrary date. Few of the different measurement approaches clearly set out reference state or baseline considerations, however, **an understanding of the reference state is critical to quantify the impacts on biodiversity.** A transparent mechanism for selecting appropriate references is key to achieving greater consistency between approaches.

Lammerant et al. (2019) further distinguish between two broad types of accounting approaches with implications for interpretation, data collection and supporting needs. The first approach assesses

[75] The Agrobiodiversity Index (ABD) from Biodiversity International measures biodiversity across three normally disconnected domains: nutrition, agriculture and genetic resources. It aims to be an action-oriented tool to identify policy and business levers, good practices, areas for improvements, and risk and opportunities to increase use and conservation of agrobiodiversity for sustainable food systems. More information: https://www.bioversity-international.org/abd-index/.

[76] Developed with business needs in mind by the Biodiversity Disclosure Project in South Africa: www.bdprotocol.org

[77] The LIFE Institute combines measures in MSA with other indicators to calculate the 'biodiversity impact index', which assesses whether companies meet a threshold and qualify for the LIFE certification.

[78] For positive impact assessment, LIFE considers operations off site, for negative, only direct site operations are considered within the calculation (Lammerant et al. 2019).

impacts on biodiversity directly. It relies both on on-site **direct measurements**[79] and biodiversity data from global data sets, such as the IUCN species range maps. The second approach uses **models** to link pressures and economic activities to biodiversity states[80]. The latter is key for footprints (see below). Some stakeholders argue that approaches based on models cannot be responsive to site-level management intervention. However, this is also not their purpose (they are not designed nor should they function as e.g. standards). Site level data may be difficult and/or costly for some business applications (e.g. sector wide impact assessment, supply risk analysis, portfolio risk assessment). In such cases **global data sets and extrapolations may be the only cost-effective means to measure the scale of biodiversity impacts**. Improving the resolution and coverage of global data would help to address these challenges.

As regards the **food industry specifically**, studies have been undertaken to assess sector-specific challenges and opportunities. For example, already in 2010 a best practices guide was developed to help point companies toward appropriate tools and methods for integrating biodiversity conservation in the food processing industry, the packaging industry and the food retail industry (Business and Biodiversity Platform 2010). Altogether it found that "the food supply industry is characterised by few publications specific to the sector and its whole chain value and their relationships with biodiversity. **The actions implemented to integrate biodiversity into food supply activities are more product-specific** and no global guidelines dedicated to the sector have been published yet" (Business and Biodiversity Platform 2010). Nonetheless, positive case studies of frontrunners were distinguished[81]. In the last 10 years, much has happened. Many food companies have their own sourcing guidelines for suppliers and farmers and implement their own audits to control compliance. LCF et al. (2017a) presents examples of good practice and maps the current state of activity in this regard. For example, Unilever has explicit criteria regarding land conversion: "The conversion of High Conservation Value/High Ecological Value/high carbon stock areas (forests, grasslands or wetlands) to farmland is prohibited" (from LCF et al. 2017a). Many of these commitments were discussed in Section 3.4.

The One Planet Program on Sustainable Food Systems[82] published a report describing and mapping key existing methodologies and **tools for biodiversity metrics in the food sector** (Neveux et al. 2018). They assessed three complementary types of initiatives, grouping them as "foundational biodiversity data and tools" (2 initiatives), "guidelines for integrating biodiversity in decision support tools" (3 initiatives) and "biodiversity decision-support tools" (6 initiatives). These are listed in more detail in the Annex (Table 7.6). Many of the tools included were also reviewed by Lammerant et al. (2018; 2019). Neveux et al. (2018) also came to similar results, finding that the many of the initiatives assessed were at least partly based on species counts (with some additionally including genetic or habitat approaches), included **land use impacts as the most frequently assessed pressure** (with water stress, pollution, and climate change taken into account to varying degrees), and were still all ongoing (with most in pilot project stages). They further highlighted the **diversity of approaches** (objectives, evaluation scale, level of expertise required, etc.) relevant to different business needs, which combined make an extensive and complementary toolkit. Nevertheless, "**more work is required before biodiversity will be mainstreamed and systematically applied in business decision making**" (Neveux et al. 2018). While the report argues against the perception that biodiversity is too complex to reliably monitor impacts, it also recognises the urgent need to improve the data basis. In particular, the availability and suitability of data

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[79] Examples of direct measurement approaches for species include observation (e.g., census, line transect, photo, video and audio), capture (e.g., traps, pitfalls), and marking (e.g., visual, collars and bands). Data on habitats are harder to classify. They include satellite imagery and ground-truthed data (based on site visits / on the ground sampling methods: e.g. random sampling, transect, quadrats, etc.).

[80] It should be noted that some approaches are hybrids.

[81] For example, Unilever had a project: Transferring knowledge from farm-based projects to supply chain action; and Carrefour had a project: Sustainability self-assessment program for suppliers and biodiversity management.

[82] A multi-stakeholder initiative that aims to promote sustainability all along the food value chain, bringing together existing initiatives and partnerships working in related areas, highlighting good practices and success stories, and building synergies as well as cooperation among stakeholders.

is a key area for research, including the adaption of data formats required for different assessment methods (Neveux et al. 2018).

## 4.3. BIODIVERSITY FOOTPRINTS

Environmental footprints have become common measures to express environmental impacts and burdens of consumption and production activities, in particular as concerns ecological footprints, carbon footprints and water footprints. No universal definition exists, as each type of footprint addresses different impacts at different scales (Fang et al. 2016). For example, one basic type of footprint can be used to answer the basic question ***"how much pressure"?*** In other words, how much land, water, carbon, raw material etc. is used in the production of a single product (product scale) or to supply the total consumption of e.g. agricultural products of a country (national scale)? In the first case, results can be used to compare products with one another to **identify potentially high impact products**. Producers can use this information to adjust practices, retailers may shift sourcing, and customers may change their purchasing behaviours. At a national level, knowledge on *how much* of a resource is consumed may allow policy makers to identify "overconsumption"[83] and adjust policy frameworks and incentives accordingly. In general, it can be said that **biodiversity footprints aim to account for how much biodiversity is lost for the production and consumption of specific products**. This assessment takes place across the life-cycle of those products and can be aggregated to e.g. sector, corporation or country levels depending on the aim of the monitoring. At all levels it can act as a **'headline indicator**' to communicate pressures on biodiversity in one aggregated metric.

Indeed, the CDC Biodiversité (2020) state that such a biodiversity footprint metric "**is now poised to shake up the business world**" (CDC Biodiversité 2020). The hope is that a biodiversity footprint will play a role similar to that of a carbon footprint for **raising awareness and mobilising action** in business, policy, civil society and research. Monitoring and easy-to-understand communication were key first steps to trigging widespread innovation in the search for alternatives to e.g. pollutive fossil fuels. **Biodiversity footprints could help point to high-impact products and areas within the food system, helping to raise awareness, drive innovation, increase acceptance toward more sustainable supplies and drive demand toward more sustainable diets** (e.g. Willet et al. 2019). The CDC Biodiversité emphasise that a biodiversity footprint must be easy to estimate and to understand by non-specialists (**transparency is crucial**) and that it should represent biodiversity for itself. Indeed, "highly resolved information on biodiversity impact can galvanise support from consumer groups and provide information for particular interventions around specific species and risk hot spots" (Green et al. 2019).

Biodiversity footprints can be applied and incorporated into company accounting and reporting. **The financial sector—in particular—has shown high levels of interest** into further developing biodiversity footprints. For example, Berger et al. (2018) review methods focused on the biodiversity footprint of the investments and loans of a financial institution. In this case, biodiversity footprints are used to assess risk in their asset portfolios. They also **provide insight into potential trade-offs** between one or more of the underlying environmental pressures. "For example, the biodiversity footprint will show if the climate benefits of the use of biomass as an energy source leads to trade-offs with regard to land use and water use" (PBAF 2020). This supports investors to be able to make better balanced investment decisions. A generic footprint of a product or company is based on sector, product and/or country-wide averages in cases where the absence of data does not allow more precise calculations. Even in such cases, biodiversity footprints **help investors to identify areas of high risk.** This suggests that while improving data accuracy is a priority for researchers, it should not obstruct the further development of methods for the business community. In any case, the actions taken by the finance community to further develop

[83] In particular related to global averages or to planetary boundaries and targets, e.g. safe space for global cropland use; asking whether national consumption levels are above or below global average "allocation" of this "safe space limit".

biodiversity footprint metrics reflect also a positive trend for steering companies toward higher levels of monitoring and action (Lammerant 2018).

Biodiversity footprints aggregated at higher levels of analysis (e.g. country) can be used to develop evidence-based policy measures. These may be integrated into existing monitoring frameworks, e.g. overarching bioeconomy monitoring[84] and national accounting structures. Resulting policy interventions to incentivise sustainable use may take the form of e.g. tax adjustments, increased R&D funding, adjustments to subsidy structures, etc. To both strengthen monitoring and support market-based 'solutions' **partnerships and joint efforts between the private sector and policy makers are vital**. Biodiversity footprints could provide a united call for action. To this end, footprints should be applicable, comparable and easy to implement.

**BOX 6: TRASE EARTH: SEEKING TO TRANSFORM OUR UNDERSTANDING OF AGRICULTURAL COMMODITY SUPPLY CHAINS**

Trase aims to increase transparency by revealing the links to environmental and social risks in tropical forest regions and creating opportunities to improve the sustainability of how these commodities are produced, traded and consumed. It uses publicly available data to map the links between consumer countries via trading companies to the places of production. Data is provided free-of-charge, and the aim is to map the trade of over 70% of total production in major forest risk commodities by 2021 (including soy, beef, palm oil, timber, pulp and paper, coffee, cocoa and aquaculture). Trase is a partnership between the Stockholm Environment Institute and Global Canopy, with a wide-range of other expert partners.

**More information: https://trase.earth**

**How biodiversity footprints are measured depends on their intended use**. In general, two basic methods exist—**input-output analysis oriented approaches** to capture higher levels of aggregation (e.g. of sectors or countries) and **life-cycle analysis oriented approaches** focused more on the product level[85]. Input-Output Analysis tracks material flows within the economy. Models in this approach are generally based on matrixes with columns representing inputs to an industrial sector and rows representing outputs. They thus provide a mathematical representation of transactions between economic sectors and final demand categories. In 'Environmentally Extended Input-Output Analysis' monetary input-output tables are combined with accounts on environmental pressures, such as land use change induced biodiversity loss, in order to indicate the environmental performance of an economic sector or product group. The approach is methodologically well established. Life-Cycle Analysis focuses on the material flows and related environmental pressures of products. These are tracked and analysed from the 'cradle to the grave', including e.g. raw material consumption and emissions. Although Life-Cycle Analysis is a well-established method with international standards, it is still subject to further development. Models that aim to assess land-use impacts have been continuously improved over the past two decades, in particular as regards biodiversity, but challenges remain (Souza et al. 2015). Scientific assessments of **biodiversity footprints from the agriculture sector**, in particular, have increased in recent years. Some of these were presented in previous chapters of this report; for example, Lenzen et al. (2012) calculated "implicated commodities" to look at the impacts of trade. Further seminal studies assess trade (e.g. Chaudhary and Kastner 2016, Pendrill et al. 2019), identify hotspots (e.g. Chaudhary et al. 2015), assess drivers (e.g. Wilting et al. 2020, Koslowski et al. 2020) and derive policy recommendations (e.g. Godar et al 2015; 2016, Green et al. 2019). Further research focuses on improving methods, including e.g. assessing indicators (Marquardt et al. 2019).

Initiatives for developing approaches and **tools for business to calculate biodiversity footprints are**

[84] The pilot report for monitoring the German bioeconomy has accounted for the agricultural land footprint of national consumption and its allocation to land use change of different types of land use in the countries of origin, categorised according to biodiversity richness (Bringezu et al. 2020).

[85] Some hybrids approaches applying both also exist, e.g. for organisations.

**underway** (and there is overlap with many of the approaches presented in Section 4.2 focused on the development of quantitative metrics; see also IUCN 2020a—"A Compass for navigating the world of biodiversity footprinting tools: an introduction for companies and policy makers"). Many are in the pilot project stages; a broadly accepted metric for a biodiversity footprint does not, yet, exist (there is no equivalent of an IPCC endorsed carbon metric). Most focus on biodiversity--rather than on ecosystem services—and account for species based on the indicators Mean Species Abundance (used e.g. in Input-Output Analysis focused approaches) or on Potentially Disappeared Fraction (used e.g. in Life-Cycle Analysis based approaches).

For example, **the Global Biodiversity Score** is being developed to measure a company's biodiversity footprint. The approach is reflective of other efforts in general and the report (CDC Biodiversité 2017) provides a solid description and overview of the basic principles. Essentially, it shows how calculating the biodiversity footprint of a business requires **creating a quantitative causal relationship between economic activities and their impacts on ecosystems.** This is a two-step process. First, pressures (such as land use change) are linked to business activities (such as cropland expansion). This is done with e.g. Input-Output modelling or Life-Cycle Analysis. Second, the impacts of these pressures on ecosystems are estimated based on – in this case -- the GLOBIO model (see BOX 7). The overriding principle is to calculate the **contribution of raw materials—including agricultural commodities—production processes to drivers in order to deduce a footprint per quantity produced. In this way a "footprint database" for all raw materials and by country is gradually compiled.** For agricultural raw materials this footprint database is the foundation for further evaluation. The data it contains is not based on the scale of specific fields, but rather on "grid cells" of the globe (it is divided into 0.5° by 0.5° grid cells—50 km by 50 km at the equator[86]). Different agricultural practices are assigned at the grid level. For example, data on national crop yields is obtained from FAO data. Five types of agricultural practices (corresponding to the five cropland types in GLOBIO) are differentiated. "The biodiversity footprint of a **given quantity** of a **given commodity** is then calculated based on 1) the national footprint previously calculated and 2) the share of the implicit surface area required for production in the total agricultural area in the country" (CDC Biodiversité 2017). This implies that the calculated footprint is **based on generic practices** instead of specific farming techniques on specific farms. The Global Biodiversity Score recognises this dichotomy explicitly, stating: "is not intended to replace local indicators which are best suited to local or on-site biodiversity assessments" (CDC Biodiversité 2017). In a related approach PBAF (2020) suggest the use of certification specific 'impact correction factors' for e.g. certified resources, but also recognise that "Even though the accuracy of the footprint may be limited due to a lack of company specific data, it offers valuable information for an investor that wants to address its potential impacts on biodiversity" (PBAF 2020).

**BOX 7: THE GLOBIO MODEL FOR MONITORING BIODIVERSITY: HOW LAND-USE CATEGORIES RELATE TO SPECIES COUNTS**

The Global biodiversity model for policy support (GLOBIO model) is a well-established model used for leading assessments of biodiversity. It is a spatialized model covering the entire surface of the planet (divided into 0.5° by 0.5° grid cells). The aim of the model is to assess the state of **biodiversity intactness** –using the indicator Mean Species Abundance (MSA) in relation to original ecosystems --in each grid cell. It is built on a set of equations linking environmental drivers and biodiversity impacts involving a two-step process: 1) assessing the intensity of accumulated pressures within each grid cell and 2) determining the impacts on biodiversity. For each of the pressures included, the model contains a regression equation. Pressure – impact relationships are derived from peer-reviewed literature (nearly 300 articles) using meta-analyses and are continuously expanded (Alkemade *et al.*, 2009). **Thirteen land-use categories are factored into the GLOBIO model**. Three categories refer to natural areas (they are not dedicated to any human activity: i.e. natural forests, natural grasslands and snow and ice). They are estimated with 100% MSA. Ten other categories correspond to: intensive agriculture (ca 12% MSA), extensive agriculture (ca 32% MSA), woody biofuel

[86] With an update to 10 arc-seconds for terrestrial systems in GLOBIO 4

agriculture, irrigated agriculture (circa 5% MSA), cultivated grazing areas (ca 61% MSA), forestry plantation (ca 32% MSA), harvest forestry, selective logging forestry, reduced impact logging forestry, and urban areas. Data on species abundance (MSA) is based on 89 peer-reviewed articles comparing species' abundance between at least one land-use type and primary vegetation. Though tropical forests are overrepresented in this sample, studies from other biomes confirm the general picture.

**More information: https://www.globio.info/**

An **appropriate interpretation of results** is needed, in particular when dealing with data with different levels of precision (PBAF 2020). The choice a baseline is critical to this: in other words, what should biodiversity footprints be compared to? For example, most uses of land will be a degradation compared to pristine nature whereas most agricultural land uses will probably be an improvement if compared to practices like "slash and burn" agriculture. Reference values need to be derived and agreed upon, in particular in cases where the original vegetation shall no longer serve as a reference, with careful consideration of objectives, transparency and comparability. One challenge is the restoration of degraded soil, in which biodiversity could be improved. PBAF (2020) suggest using multiple reference situations.

**The Product Biodiversity Footprint (PBF)** is an example of an approach based on a Life-Cycle Analysis orientation (Asselin et al. 2019). It is under development by a public private research and development partnership initiated in 2017[87] with the aim of guiding decision making in product design with a focus on biodiversity. The method is centred around addressing and providing indicators for each of the five drivers of loss of biodiversity as defined by the Millennium Ecosystem Assessment throughout the value chain, noting that convergence towards a single indicator is a strong request from industry and policy makers. The method quantifies the driver "habitat change" using the species richness indicator "potentially disappeared fraction". This basically expresses the potential disappearance of species across a spectrum (a maximum value of 1 means that all species have disappeared and zero means that all species are still there) and is often expressed for a certain area and over a given time period[88]. Habitat change is linked to land occupation and direct land transformation[89]. In this case six different land categories are characterised: primary forest, secondary forest, annual crops, perennial crops, grassland and urban land. The change of land use along this sequence would thus indicate fundamental loss of biodiversity. At the same time, **the practitioner could not distinguish between different agricultural practices.** The study provided a case study of specific products and intends to develop a more automated tool, with a limited number of input data, "to facilitate practical use for eco-design within companies. This tool will be developed together with a database containing ecology related data and literature" (Asselin et al. 2019).

In a scientific assessment Chaudhary et al. (2016) quantified **biodiversity impacts per kilogram of crop for over 160 individual crops from 250 different countries.** The study made progress on life-cycle analysis methods by combining high resolution yield and area maps of global crops with ecoregion specific 'characterisation factors' for annual and permanent crops. Characterisation factors indicate species loss caused by unit area of a particular land use[90]. It was thus able to identify "the most damaging

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[87] By I-Care & Consult and codeveloped by I-Care & Consult and Sayari, funded by the French Environmental Protection Agency (ADEME), and three private companies : L'Oréal, Groupe Avril and Keering.

[88] Noting as a weakness that this indicator is difficult to understand beyond the LCA community

[89] Inventory of land transformation is limited to changes in the last 20 years and accounts for land use change directly caused by the expansion of the production area of the contemplated commodity; ways to account for indirect land transformation induced due to additional pressure on land use are underway.

[90] They are calculated by combining indicator models on countryside 'species area relationship' and the taxa-specific 'vulnerability score'. The first aims to assess how much an ecosystem is already affected by land use pressures. The second addresses the vulnerability of species inhabiting a particular region to future land use pressures. The input data to calculate characterisation factors comes with uncertainties and limitations. For example, local characterisation factors "do not inform regarding the contribution of land use toward potential irreversible, global extinction of rare and threatened species due to habitat loss/degradation" (Chaudhary et al. 2016).

land use types causing high species loss for mammals, birds, amphibians, and reptiles globally and also on a regional scale at 5 arc minute resolution"[91]. Aggregating the results to a country level and combining findings with trade data enabled Chaudhary et al. (2016) to assess biodiversity impacts embodied in, for example, traded food commodities.

Research to improve biodiversity and land use change integration into life-cycle analysis approaches are in full swing. In general there are three models which account for spatialisation to differing degrees: Impact World+ (Bulle et al. 2019), ReCiPe (Huijbregts et al. 2016) and LC-Impact[92] (Verones et al. 2016). Shortcomings regarding land use are being addressed (Curran et al. 2016). Altogether, life-cycle analysis "**already deals with the potential biodiversity impacts of land use, but there are significant obstacles to overcome before its models grasp the full reach of the phenomena involved"** (Souza et al. 2019). Data uncertainty (Meyer et al. 2016) is one obstacle which science is addressing. Further development of business tools may be expected to occur simultaneously.

# 5. CONCLUSIONS

There are clear goals to halt biodiversity loss worldwide. These are becoming more pressing in the post-2020 global sustainability framework and **efforts to operationalise targets for the business context have put the urgency and scale of the kind of action needed into perspective**. Land use change plays a key role as a driver of biodiversity loss, and expansion of agricultural land into natural systems must be halted at 'no conversion' or better (in the sense of restoration). There are several approaches to link the production of consumer products to land use and land use change as well as to biodiversity directly. This paper chose to group these roughly into three categories based on the type of role each fulfilled, but this is certainly not exhaustive.

**Standards and certification** are the most well-established field with structures, routines and processes in place. Standards can particularly help to achieve a continuous improvement towards halting the loss of biodiversity on and beyond farms **associated with on-site practices.** To this end, biodiversity criteria must be strengthened in a way that balances rigor and transparency with accessibility and uptake. However, certification is not a tool well-suited to halting land use change at higher landscape scales (this is also not what it was designed to do). The risk of indirect effects (like farmland expansion) depends on the overall demand for land-based products. To this end, complementary approaches are needed to put food products in the context of overarching land use. The same challenge is seen for "zero deforestation" commitments. Namely, uptake at scales needed to be effective. To improve effectiveness, widespread adoption of '**zero-gross deforestation**' targets with immediate implementation deadlines and sanction-based implementation mechanisms is needed (Garrett et al. 2019).

Identifying and addressing hot spots is the key focus of **business guidelines promoting internal, process-oriented approaches to monitoring.** These emphasise the need for companies to monitor their own biodiversity pressures and impacts. Multiple guidelines have been published recently to support business, and these provide key information sources geared toward different business applications. Increased supply chain transparency is a key aspect here. **Private-public partnerships** can support the development of ethical supply chains and the conditions which enable them (Gardner et al. 2018). "Identifying links between the intensification and expansion of agricultural commodity production and

[91] For example, the study found that „Crops such as coffee, rubber, tea, palm oil, and soybean have a disproportionally high biodiversity footprint considering the fact that they only occupy less than 10% of global agricultural land. This is because these crops occupy biodiversity-rich regions hosting high number of endemic and threatened species" (Chaudhary et al. 2016).

[92] A flagship project of the UNEP/SETAC Life Cycle Initiative, entitled 'Environmental Life Cycle Impact Assessment Indicators', aiming to provide global guidance and build consensus on life cycle impact indicators, such as biodiversity loss. The European LC-IMPACT project method provides two indicators, one for global species extinctions and another one for regional extinctions.

the demand that drives it is a vital first step to engage the political and private actors with the greatest responsibility and influence" (Green et al. 2019). Companies will be able to use this information to understand and mitigate risks in their supply chains, while customers, civil society and shareholders can use it to hold governments and businesses to account.

**Biodiversity footprints** are one tool for business to communicate the impacts of their products in a **headline indicator.** The results — or lessons learned — may be used for the design of new products. In comparison to other sectors, the food industry has high impacts on biodiversity (Wilting et al. 2020). This is to be expected as agriculture requires *using* land. Biodiversity footprints could help to approach the overarching objective of sustainable *use* of natural resources within planetary boundaries. Biodiversity footprints at a product level could help drive transformational shifts within food systems towards more sustainable use of land and biodiversity. Biodiversity footprints at the national level could support policy makers to keep total consumption – including supply of retail – within the planetary boundaries. In other words, monitoring *how much* global biodiversity is lost for the production of food products consumed in that country and supporting innovation, adjusting incentive frameworks and empowering stakeholders to enact deep changes in how and what food is consumed. Such a metric could help to **unite global efforts**. In this case, the method should be easy to understand, applicable, comparable and easy to implement. Development of biodiversity footprint metrics is just beginning. Some approaches have been applied in the research arena, and testing the applicability for business has started in a few cases.

The questions to the food industry are, **what should science prioritise as key areas for research to strengthen the robustness and usefulness of methods, and which aspects of biodiversity should be monitored with footprint approaches?** The aim of this report was to develop and provide a common basis for addressing these questions together. We will continue to monitor and support the evolution of tools to better account for biodiversity and ecosystem services in products from the field to the shelves and on to the fork.

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# 7. ANNEX

## TABLE 7.1 THE IMPLICATIONS OF PLANETARY BOUNDARIES FOR BUSINESS

| Planetary boundary | Control variable | | Status | Implications for business |
|---|---|---|---|---|
| | Global | Sub-global | | |
| **Climate change**<br>Global temperature has risen by nearly 0.7°c since 1950, mostly due to $CO_2$ emissions from fossil fuel use. | Atmospheric $CO_2$ concentration ppm | | INCREASING RISK<br>In zone of uncertainty | $CO_2$ emissions must decrease, soon and sharply. Climate change, energy security and economic stability are tightly linked. Assets and business activity will be affected by rising temperatures, more frequent weather extremes, and sea-level rise. |
| **Loss of biosphere integrity**<br>Wild animal populations have roughly halved since 1970, and ecosystems worldwide have been impacted by human activities. | *Genetic diversity:* Extinction rate<br>*Functional diversity:* Biodiversity Intactness Index (BII) | | HIGH RISK<br>Beyond zone of uncertainty | Business cannot function if ecosystems are degraded or out of balance. Nature provides directly beneficial services – food, fibre, fuel. It also provides many invisible but essential services, such as regulation of climate and the water cycle, air quality improvements, flood protection. It also contributes to cultural and individual wellbeing. |
| **Changes to biogeochemical flows –**<br>N and P are essential nutrients for all life. Exponential rises in N and P emissions from industry and intensive agriculture kill lake and marine life, cause severe air pollution and affect climate patterns. | *Nitrogen:* amount of N applied to land per year<br>*Phosphorus:* P flowing into oceans | *Regional:*<br>*Phosphorus:* P flow from fertilisers to erodible soils | HIGH RISK<br>Beyond zone of uncertainty | Humanity faces a global challenge to produce more food and energy without eroding its ecological life-support systems. Global disparities in food and energy security are severe. The environmental release of N and P is becoming an unaffordable waste of natural resources. |
| **Land use change (forest conversion to croplands, roads and cities)**<br>As well as killing wildlife, deforestation and urbanization affect climate by changing $CO_2$ flows | Area of forested land as % of original forest cover | *Biome:*<br>Area of forested land as % of potential forest | INCREASING RISK<br>In zone of uncertainty | Business has caused a significant part of the world's large-scale land degradation and deforestation. It can make a major difference by adopting and promoting sustainable land management practices and policies. |
| **Release of novel entities**<br>Synthetic substances – and even novel life-forms – can radically alter Earth's biological and physical dynamics, bringing entirely new systemic risks to human societies. | No control variable currently defined | | Boundary not yet quantified | Business plays a unique role as the producer of novel entities, many of which are essential in modern society (medicine, agriculture, consumer goods, new technologies). Urgent reduction in releases of harmful substances means a renewed focus on sound chemicals management by business. |
| **Atmospheric aerosol loading**<br>Microparticles emitted into the air cause severe local pollution problems that can cascade up to global impacts on nature and climate. | Aerosol Optical Depth | *Regional:*<br>Aerosol Optical Depth as a seasonal average over a region | Boundary not yet quantified | Atmospheric aerosols have complex impacts, but all business action to address air pollution at the local level to is likely to help tackle the systemic global problem too. Avoid "exporting pollution" by shifting manufacturing to places with lax regulatory controls. |
| **Freshwater abstraction**<br>Water use impairs or even dries up rivers and aquifers, harming the environment and altering the hydrological cycle and climate. | Amount of blue water use | *Basin:*<br>Amount of blue water withdrawal as % of mean monthly river flow | SAFE<br>Below boundary | All business action at the local level to minimise water waste and reduce the release of pollutants into the environment will help to reduce pressure on the planetary boundary. |
| **Ocean acidification**<br>Tightly coupled to climate change through absorption by oceans of $CO_2$ and formation of carbonic acid, today's rate of ocean acidification is unprecedented in over 65 million years. Early effects on marine life are becoming evident. | Carbonate ion concentration | | SAFE<br>Below boundary | The rise in carbon dioxide emissions must halt – and the sooner, the better. Delaying the $CO_2$ emissions peak will require higher mitigation rates, with higher costs and higher climate risks. |
| **Loss of stratospheric ozone**<br>The 'ozone hole' allows more harmful UV light to reach Earth's surface. The minimum ozone concentration has now been steady for ~15 years after the phasing out of ozone depleting substances. | | | SAFE<br>Below boundary | This is often seen as a success story, but the good work to reduce environmental release of ozone depleters must continue. Avoid "exporting pollution" by continuing use of these substances in places not yet subject to international regulatory controls. |

Source: CISL 2019

### Table 7.2 Biodiversity models and indicators used in the proof-of-concept analysis of the Bending the curve initiative and related biodiversity metrics

| Biodiversity model | Indicator | Biodiversity aspect |
|---|---|---|
| Living Planet Index (LPI-M) model | Living Planet Index (LPI-M \| LPI) | abundance of birds and mammals |
| INtegrated ScenarIos of Global HabiTat for Species (INSIGHTS) model | Extent of Suitable Habitat (INSIGHTS \| ESH) | extent of suitable habitat of mammals |
| Asia-Pacific Integrated Model (AIM- biodiversity) | Extent of Suitable Habitat (AIM-B \| ESH) | extent of suitable habitat for vascular plants, amphibians, reptiles, birds, and mammals |
| Projecting Responses of Ecological Diversity In Changing Terrestrial Systems (PREDICTS) model | Biodiversity Intactness Index (PREDICTS \| BII) | compositional integrity of ecological assemblages (based on abundance of original species) |
| Global Biodiversity (GLOBIO) model | Mean Species Abundance (GLOBIO \| MSA) Index | compositional integrity of ecological assemblages (based on abundance of original species) |
| Countryside Species-Area Relationship (cSAR) model | Fraction of remaining regional species (cSAR \| FRRS_CB17), Fraction of remaining endemic species (cSAR \| FRES_CB17), Extirpation index (cSAR \| ETPI_US16), Extinction index (cSAR \| EXCI_US16) | long-term extirpation (for FRRS_CB17), extinction of species (for FRES_CB17) of mammal, bird and amphibian species,<br>long-term extirpation (for ETPI_US16), potential long-term extinction (for EXCI_US16) of species of mammals, birds, amphibians, reptiles and vascular plants |
| Biogeographic modelling Infrastructure for Large-scale Biodiversity Indicators (BILBI) | Fraction of remaining plant species (BILBI \| FRPS) | long-term extinction of vascular plants |
| Madingley model | Abundance density index (Madingley \| ADI) | abundance of all organisms |

Source: Leclère et al. 2018; See the study for more information on the metrics and related sources

### TABLE 7.3. RESOURCES FOR BUSINESS: INITIATIVES, PARTNERSHIPS, PLATFORMS AND PROGRAMMES

| Resource | Description |
|---|---|
| Aligning business measures for biodiversity | The Aligning Biodiversity Measures for Business collaboration led by UNEP-WCMC and with partners across >20 organisations convenes key stakeholders to improve clarity and build consensus on how businesses and financial institutions can measure and report on performance. The collaboration seeks to form a common view on the measurement, monitoring and disclosure of corporate impacts and dependencies on biodiversity, and then to integrate credible and comprehensive corporate measurement into external reporting/disclosure and global biodiversity policy. https://www.unep-wcmc.org/featured-projects/aligning-biodiversity-measures-for-business |
| Biodiversity in Good Company: Business and Biodiversity Initiative | A cross-sectorial collaboration of companies that have joined forces to protect and sustainably use our worldwide biological diversity. Through this commitment they contribute to the Convention on Biological Diversity (CBD). Its aim is to halt the dramatic loss of ecosystems, species and genetic diversity. Developed for example a "Corporate Biodiversity Management Handbook. A guide for practical implementation" in 2012. www.business-and-biodiversity.de |
| Biodiversity Indicators Partnership | A global initiative to promote the development and delivery of biodiversity indicators. Its primary role is to serve the global user community by responding to the indicator requests of the CBD and other biodiversity-related Conventions, for IPBES, for reporting on the Sustainable Development Goals, and for use by national and regional governments. https://www.bipindicators.net |
| Biodiversity Monitoring System | Allows standards and food companies to monitor the biodiversity performance of certified farms and/or supplying farmers. The monitoring is based on 25 indicators with high relevance for the protection and creation of potential for biodiversity and the reduction of negative impacts. Standards and food companies have protected access to include data of their associated farms, to aggregate data sets and to elaborate multiple options of analysis by combining the 25 indicators. https://bms.biodiversity-performance.eu |
| Business for Nature | Business for Nature is a global coalition bringing together influential organisations and forward-thinking businesses to demonstrate business action and call for governments to reverse nature loss. |
| Cool Farm Alliance | An Industry platform for sustainable agriculture metric development and use. More information: https://coolfarmtool.org/cool-farm-alliance/ |
| Corporate Ecosystem Services Review (ESR) | Developed by the WBCSD/WRI - which consists of a structured methodology that helps managers proactively develop strategies to manage business risks and opportunities arising from their company's dependences and impacts on ecosystems. |

### TABLE 7.3. RESOURCES FOR BUSINESS: INITIATIVES, PARTNERSHIPS, PLATFORMS AND PROGRAMMES

| Resource | Description |
|---|---|
| CSR Europe | CSR Europe is the leading European business network for Corporate Sustainability and Responsibility. They unite, inspire and support over 10,000 enterprises at the local, European and global levels in their transformation and collaboration towards sustainable growth. |
| Eco4Biz | Ecosystem services and biodiversity tools to support business decision-making" is a structured overview of existing tools and approaches published by the World Business Council for Sustainable Development: http://www.wbcsd.org/eco4biz2013.aspx |
| EU Business @ Biodiversity Platform | The EU Business @ Biodiversity Platform provides a unique forum for dialogue and policy interface to discuss the links between business and biodiversity at EU level. It was set up by the European Commission with the aim to work with and help businesses integrate natural capital and biodiversity considerations into business practices. https://ec.europa.eu/environment/biodiversity/business/index_en.htm |
| EU LIFE Initiative Food & Biodiversity | To improve the biodiversity performance of standards and sourcing requirements in the food industry by helping standard organisations to integrate efficient biodiversity criteria into their schemes and motivating food processing companies and retailers to include comprehensive biodiversity criteria into their sourcing guidelines. It includes the Biodiversity Performance Tool. https://www.biodiversity-performance.eu |
| European Business and Biodiversity Campaign | The European Business and Biodiversity Campaign was initiated in 2010 by a consortium of European NGOs and companies led and coordinated by the Global Nature Fund (GNF) with support of the LIFE+ Programme. Among other things EBBC aims to inform the private sector about the importance of biodiversity and tools available to assess dependence and mitigate impacts on biodiversity: www.business-biodiversity.eu |
| Global Platform on Business and Biodiversity | The Global Platform on Business and Biodiversity stems from the ongoing engagement of the Convention on Biological Diversity (CBD) with the business sector. This global partnership provides a global forum of dialogue among signatory Parties and other Governments, businesses, and other stakeholders, and encourages the establishment of national and regional business and biodiversity initiatives. The Global Platform on Business and Biodiversity serves as the Partnership's website and offers numerous case studies, tools and other relevant information. |
| Global Reporting Initiative | Approach for Reporting on Ecosystem Services: Incorporating ecosystem services into an organization´s performance disclosure. http://www.bipindicators.net/LinkClick.aspx?fileticket=s9Q16GObfEw%3D&tabid=155 |

### TABLE 7.3. RESOURCES FOR BUSINESS: INITIATIVES, PARTNERSHIPS, PLATFORMS AND PROGRAMMES

| Resource | Description |
|---|---|
| IPBES - Business & Biodiversity Assessment | The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the intergovernmental body which assesses the state of biodiversity and of the ecosystem services it provides to society, in response to requests from decision makers. Their new adopted work programme (2019-2030) includes a methodological assessment of the impact and dependence of business on biodiversity and nature's contributions to people that aims at categorizing how businesses depend on, and impact, biodiversity and nature's contributions to people and identifying criteria and indicators for measuring that dependence and impact, taking into consideration how such metrics can be integrated into other aspects of sustainability. |
| IUCN Business & Biodiversity Program | IUCN aims to transform with its Business and Biodiversity Program the way business values, manages and invests in nature, highlighting the opportunities and benefits of a more sustainable approach. IUCN seeks to build an action-based relationship with business that goes beyond Corporate Social Responsibility obligations, addressing the root causes of environmental degradation. The Global Business and Biodiversity Programme provides a wide range of expertise. It builds bridges between stakeholders, carries out independent scientific assessments, and develops conservation policy standards and tools. |
| Natural Capital Coalition | The Natural Capital Coalition is a global, multi-stakeholder open source platform for supporting the development of a Natural Capital Protocol aiming to set the industry norms for valuing and accounting for natural capital in business. Developed by WBCSD, the Natural Capital Protocol and sector guides complement and facilitate business uptake by consolidating the wealth of tools, methodologies and approaches available for natural capital measurement and valuation. https://naturalcapitalcoalition.org/protocol-toolkit/ |
| Natural Value Initiative | An initiative led by UNEP FI and Fauna & Flora International – assessing the dependency on biodiversity and ecosystem services of 31 companies within the Food, Beverage and Tobacco sectors. This initiative has been designed in the primarily for the financial sector (investors and rating agencies). |
| Slow Food Foundation for Biodiversity | Active in over 100 countries, the Foundation involves thousands of small-scale producers in its projects, providing technical assistance, training, producer exchanges and communication. Furthermore, it provides technical tools for various projects (guidelines, production protocols, manuals, etc.), explores the themes related to these projects (sustainable agriculture, raw milk, small-scale fishing, animal welfare, seeds, GMOs, etc.), and communicates ideas and activities related to biodiversity through Slow Food's training and communication activities: https://www.fondazioneslowfood.com/en/ |

### TABLE 7.3. RESOURCES FOR BUSINESS: INITIATIVES, PARTNERSHIPS, PLATFORMS AND PROGRAMMES

| Resource | Description |
| --- | --- |
| The Economics of Biodiversity and Ecosystem Services (TEEB) | TEEB for Business puts a special focus on the impacts on and dependence of the private sector regarding biodiversity and ecosystem services. TEEB for Agriculture and Food: http://www.teebweb.org/wp-content/uploads/2014/03/TEEB-for-Agriculture-and-Food_Concept-note1.pdf |
| The Sustainable Food System of the One Planet Programme | Responding to these many challenges requires a systems-based approach that addresses the range and complexity of interactions in the production and consumption of food. The Sustainable Food System (SFS) Programme contributes to this by building synergies and cooperation among stakeholders along the pathway to more sustainable food systems. https://www.oneplanetnetwork.org/sustainable-food-systems/abou |
| UN Global Compact | Corporate sustainability initiative with reports on e.g. Guideline: Sustainability in the supply chain: http://www.unglobalcompact.org/docs/issues_doc/supply_chain/SupplyChainRep_DE.pdf |
| We Value Nature | We Value Nature is a campaign supporting businesses and the natural capital community to make valuing nature the new normal for businesses across Europe. |
| World Business Council on Sustainable Development | The World Business Council for Sustainable Development (WBCSD) brings together some 200 companies dealing with sustainable development and business. |

**TABLE 7.4 SELECTION OF INDICATORS ON IMPACTS OF AGRICULTURE ON BIODIVERSITY BY LOH 2015**

| Thematic area | Indicator | Units | Spatial Scale (of monitoring) | Temporal Scale (of monitoring) |
|---|---|---|---|---|
| Land Cover and Ecosystems | Conversion/loss of natural habitat cover | Ha/yr or $km^2$/yr | Region and landscape: remote sensing | 5-10 years |
| | Percent of land area in different habitat classes based on tree density or species diversity | Percent in each class, or weighted index score | Landscape and farm | 3-5 years |
| Wildlife/Species | Presence/absence or counts of selected species at randomized sampling sites | Index score | Region and landscape | 5-10 years |
| Domesticated Species/Genetic Diversity | Diversity of breeds or cultivars on farms | Index score | Region and landscape | 3-5 years |
| Water Quality | Biological oxygen demand at sampling sites | $BOD_5$ (mg $O_2$/litre over 5 days) | River basin | 1-3 years |
| Water Use | Water footprint (irrigation and processing) of product | $m^3$/tonne | Farm (can be scaled up) | Annual |
| Soil | Soil organic matter | Carbon content (%) in top soil | Landscape and farm scale | 1-3 years |
| Agrochemical Use | Pesticide use and inorganic fertilizer use | Kg/ha/yr (active ingredient or P-equivalent) | Landscape and farm scale | Annual |
| Energy use | Carbon footprint (land use and processing of product) | KgC/tonne product | Farm (can be scaled) | Annual |

Source: Loh 2015 as part of the 'Initiative for Biodiversity Impact Indicators for Commodity Production'

### TABLE 7.5 TOOLS AND DESCRIPTIONS OF METHODS REVIEWED BY LAMMERANT ET AL. 2019

| Tool | Description |
|---|---|
| Agrobiodiversity Index (ABD) from Biodiversity International | ABD assesses risks in food and agriculture related to low agrobiodiversity. Index based on 33 indicators. Assesses: dietary diversity, crop diversity, seed genetic diversity, level of safeguarding for the future, and benefit to local livelihoods. |
| Biological Diversity protocol from the Endangered Wildlife Trust (South Africa) | This protocol is aligned to the Natural Capital Protocol. It helps provide biodiversity-specific guidance to measuring changes in the state of natural capital (step 6 of the Natural Capital Protocol), by providing guidance on how to measure change(s) in biodiversity components affected by business. It differs from the other measurement approaches in that it offers an accounting framework. |
| Biodiversity Footprint Financial Institutions from ASN Bank (NL) | The BFFI is designed to provide an overall biodiversity footprint of the economic activities a financial institution (FI) invests in. The methodology allows calculation of the environmental impact and the environmental footprint of investments within an investment portfolio |
| Biodiversity Indicators for extractives (BIE) from UNEP-WCMC, Conservation International and Fauna and Flora International | It is a joint initiative with Conservation International and Fauna & Flora International, with support from IPIECA and the Proteus Partnership. The project has developed and it is testing a methodology that meets the needs of extractive companies in understanding their performance in mitigating their impacts on biodiversity. The methodology is being piloted by extractives companies throughout 2019 and will be refined following feedback from the pilots then published for broader uptake. Proteus research help its members to develop expertise in biodiversity using diagnostic assessment and deployment tools tailored to analysis at production and extraction site level. At present, its focus is shifting to a more global approach to provide an analytical overview of biodiversity issues at site or group level, thus requiring the analysis to be extended either up or down the value chain. |
| Biodiversity Impact Metric (BIM) by Cambridge Institute for Sustainable Leadership (UK) | BIM has been design to assess the impacts of a company's activities from raw material sourcing. It provides information of how and where the company can reduce their impact. BIM has been developed to assess impact in soil and water that, combined with biodiversity, will be called 'Healthy Ecosystems Metrics' but will be released late 2019 and are designed to assess a company's contribution to maintenance of an ecologically functional landscape. |
| Biodiversity Performance Tool for Food Sector from Solagro (France) | The Biodiversity Performance Tool (BPT) is being elaborated in the frame of the EU LIFE Project "Biodiversity in standards and labels for the food sector" aims at proposing a methodology to quite easily assess the integration of functional biodiversity at farm level for food sector actors (product quality or sourcing managers) as well as for certification companies (certifiers and auditors). The BPT should help farmers and farm advisors to elaborate and implement sound Biodiversity Action Plans, which contribute substantially to a better biodiversity performance on farm level. The tool will support auditors and certifiers of standards as well as product, quality and sourcing managers of food companies to better assess the preservation and improvement of integration of biodiversity at farm level. |

### TABLE 7.5 TOOLS AND DESCRIPTIONS OF METHODS REVIEWED BY LAMMERANT ET AL. 2019

| Tool | Description |
|---|---|
| Biodiversity Monitoring Tool for the Food Sector from Lake Constance Foundation (Germany) | The tool (also elaborated in the frame of the EU LIFE Project "Biodiversity in standards and labels for the food sector") has been created to offer food standards and food companies the possibility to monitor certain aspects with relevance for biodiversity of their certified farms / their producers. The monitoring is divided into two levels. Level 1 monitoring is a system wide approach with indicators to evaluate the potential created for biodiversity (ecological structures, biotope-corridors, buffer zones, etc.) and the reduction of negative impacts on biodiversity (use of chemical pesticides and fertilizers, erosion, water use, etc.). Level 2 is an In-depth sampling beyond the scope of certification. It monitors mid- and long-term effects of certification on wild biodiversity on the farm and its direct surroundings by selected key indicator species. |
| Global Biodiversity Score from CDC Biodiversité (France) | It provides an overall and synthetic vision of the biodiversity footprint of economic activities. It is measured by the mean species abundance. Mean Species Abundance (ratio between the observed biodiversity and the biodiversity in its pristine state) based on PBL Netherlands Environmental Assessment Agency's model of five terrestrial pressures (land use, nitrogen deposition, climate change, fragmentation, infrastructure/ encroachment) and 5 aquatic pressures, and their impacts on biodiversity. |
| Enviornmental Profit and Loss from Kering (France) | The EP&L measures carbon emissions, water consumption, air and water pollution, land use, and waste production along the entire supply chain, thereby making the various environmental impacts of the company's activities visible, quantifiable, and comparable. These impacts are then converted into monetary values to quantify the use of natural resources. Each of these externalities was audited for each Puma production site and at the different levels of the supply chain. The EP&L helped Puma reduce its environmental impacts and highlight the fact that the most part was caused by supplies, especially raw materials. |
| LIFE Key from LIFE Institute (Brazil) | LIFE Methodology helps organizations in identifying their impacts and designing a strategic plan to reduce, mitigate and compensate for them, including a specific approach to reduce impacts in the supply chain. By using the LIFE Biodiversity Estimated Impact Value (BEIV) an organization calculates and evaluates an organization's impact based on five environmental aspects taking into account quantity and severity criteria. |
| Product Biodiversity Footprint from I CARE – Sayari (France) | Combines biodiversity studies and companies' data to quantify the impacts of a product on biodiversity all along the product's life cycle stages in order to provide recommendations for changes |
| Species Threat Abatement and Restoration (STAR) Metric from IUCN (International) | The STAR* measures the contribution that investments can make to reducing species extinction risk.It can help the finance industry and investors target their investments to achieve conservation outcomes, and can measure the contributions these investments make to global targets such as the Sustainable Development Goals. |

Source: adopted from Lammerant et al. 2019

### Table 7.6 Three complementary types of initiatives for the food sector assessed by Neveux et al. 2019

| Grouping | Description |
|---|---|
| **Foundational biodiversity data and tool**: not directly useable for decision making, but deliver data on which other assessment methods can build | IBAT: Integrated biodiversity assessment tool; Predicts (Projecting Responses of Ecological Diversity in Changing Terrestrial Systems); GLOBIO (modelling human impacts on biodiversity |
| **Guideline**s: aim at establishing consensus on how biodiversity should be assessed | Land Use Impacts on Biodiversity in Life Cycle Impact Assessment; Biodiversity in Standards and Labels of the Food Sector), Guidelines for Biodiversity in Forest Landscape Restoration Assessments (IUCN) and the Restoration Opportunities Assessment Methodology |
| **Biodiversity decision support tools**: built on foundational data and implement guidelines into a simplified interface useful for a non-expert audience | (LC-METHOD method, project biodiversity footprint, biodiversity impact metric, biodiversity performance tool, agrobiodiversity index, root). Some focus on product innovation and use product-level decision support tools (LC-IMPACT, product biodiversity footprint) whereas others focus on agricultural productions (e.g. biodiversity impact metric, biodiversity performance, agrobiodiversity index) and others on a territorial level looking at food system tools such as ROOT. |

Source: Adapted from Neveux et al. 2019

### Table 7.7. Further tools and related initiatives, directed at e.g. farmers, policy makers and investors with potential spillovers for the food industry

| Tools and Resource | Description and link |
|---|---|
| Biodiversity and value chains | From the Shift; a new, four-part programme to create a community of frontrunners. Companies joining the community will commit to integrating biodiversity into their strategies and taking concrete action in their value chains. https://theshift.be/en/projects/biodiversity-in-my-value-chain |
| Biodiversity-specific return on investment metric (BRIM) from IUCN | The BRIM apportions the relative contribution of threats (pressures) to each threatened species' extinction risk. For a particular site, land management unit,<br>or administrative region (country or province), the BRIM shows the potential for reducing extinction risk before investment activities start (ex-ante measure), or can measure the achieved impact of conservation interventions on extinction risk over time (ex-post measure). https://www.iucn.org/sites/dev/files/content/documents/brim_one_pager_12dec2017.pdf |

**TABLE 7.7. FURTHER TOOLS AND RELATED INITIATIVES, DIRECTED AT E.G. FARMERS, POLICY MAKERS AND INVESTORS WITH POTENTIAL SPILLOVERS FOR THE FOOD INDUSTRY**

| Tools and Resource | Description and link |
|---|---|
| Cool Farm Tool - module Biodiversity | Quantifies how well farm management supports biodiversity. More information: https://coolfarmtool.org/coolfarmtool/biodiversity/ |
| Ecological Focus Areas (EFAs) Calculator | The EFA software is a prototype tool that has been designed to perform two key functions: (1) Provide a facility to describe and declare features on the farm as Ecological Focus Areas (EFAs) and (2) Assess the impact of features on the farm with respect their potential effects on ecosystem services, biodiversity and farm management. http://sitem.herts.ac.uk/aeru/efa/about.htm |
| ENCORE (Exploring Natural Capital Opportunities, Risks and Exposure) | a tool to help users better understand and visualise the impact of environmental change on the economy. By focusing on the goods and services that nature provides to enable economic production, it guides users in understanding how businesses across all sectors of the economy depend on nature, and how these dependencies might represent a business risk if environmental degradation disrupts them. ENCORE was developed by the Natural Capital Finance Alliance in partnership with UNEP-WCMC and was financed by the Swiss State Secretariat for Economic Affairs (SECO) and the MAVA Foundation. https://encore.naturalcapital.finance/en/about |
| Ex-ACT tool project – biodiversity indicator (FAO and AFD) | Enhance the existing tool Ex-ACT (carbon balance tool) by integrating an agriculture biodiversity indicator: http://www.fao.org/tc/exact/ex-act-home/en/ |
| Farm Sustainability Assessment | A comprehensive approach to farm sustainability built around a free set of simple questions which standardise farm assessment. It is also a web-app only available to SAI Platform members. https://saiplatform.org/fsa/ |
| Gaïa Biodiversity Yardstick | As a farmer you can use the GAIA biodiversity yardstick (a free internet tool) to get an idea of the on-farm biodiversity. The yardstick makes biodiversity measurable and comparable (with benchmarks). The biodiversity yardstick consists of 40 questions on 6 themes. https://www.gaia-biodiversity-yardstick.eu |

**TABLE 7.7. FURTHER TOOLS AND RELATED INITIATIVES, DIRECTED AT E.G. FARMERS, POLICY MAKERS AND INVESTORS WITH POTENTIAL SPILLOVERS FOR THE FOOD INDUSTRY**

| Tools and Resource | Description and link |
|---|---|
| InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) | A suite of free, open-source software models used to map and value the goods and services from nature that sustain and fulfill human life. It helps explore how changes in ecosystems can lead to changes in the flows of many different benefits to people. InVEST models are spatially-explicit, using maps as information sources and producing maps as outputs. InVEST returns results in either biophysical terms (e.g., tons of carbon sequestered) or economic terms (e.g., net present value of that sequestered carbon). The spatial resolution of analyses is also flexible, allowing users to address questions at local, regional, or global scales. InVEST models are based on production functions that define how changes in an ecosystem's structure and function are likely to affect the flows and values of ecosystem services across a land- or a seascape. https://naturalcapitalproject.stanford.edu/software/invest |
| IP Suisse | Biodiversity system points based on surface area (all ecological infrastructures detailing quantity (surface area), quality and management + relevant farming practices). Evidence-based. Monitoring (private) and online tool. Really powerful tool in Switzerland, and comforted by scientific evidence on improvement of biodiversity at farm scale. Interesting indicators are to be used for BPT |
| IUCN International: methodology for a national biodiversity audit | As for carbon foot- print, the idea is to assess the biodiversity footprint of domestic demand including the impact of the trade balance as well as the footprint of national productions and households. For instance, the biodiversity footprint of French products manufactured in China will be allocated to the French biodiversity footprint, while the footprint of exported products will be counted in the footprint of importing countries. As for the previous project, the basis of measurement will draw on the IUCN's Red List of threatened species. |
| LEAF = Linking Environment And Farming Sustainable Farming Review | The LEAF Sustainable Farming Review is a members only self-assessment on-line management tool to help farmers farm more sustainably. It enables them to monitor their performance, identify strengths and weaknesses and set targets for improvement across the whole farm.The LEAF Sustainable Farming Review covers the 9 sections of Integrated Farm Management (IFM): Organisation and Planning, Soil Management and Fertility, Crop Health and Protection, Pollution Control and By-Product Management, Animal Husbandry, Energy Efficiency, Water Management, Landscape and Nature Conservation, Community Engagement: https://leafuk.org/farming/leaf-sustainable-farming-review |
| Livestock environmental assessment and performance partnership (FAO) | Review of indicators and methods to assess biodiversity: http://www.fao.org/3/a-av151e.pdf |

**TABLE 7.7. FURTHER TOOLS AND RELATED INITIATIVES, DIRECTED AT E.G. FARMERS, POLICY MAKERS AND INVESTORS WITH POTENTIAL SPILLOVERS FOR THE FOOD INDUSTRY**

| Tools and Resource | Description and link |
|---|---|
| Resource Watch | A dynamic platform that leverages technology, data, and human networks to bring unprecedented transparency about the planet right now. Resource Watch features hundreds of data sets all in one place on the state of the planet's resources and citizens. Users can visualize challenges facing people and the planet, from climate change to poverty, water risk to state instability, air pollution to human migration, and more. Resource Watch is currently in Beta form. https://resourcewatch.org/about |
| SMART – Sustainability Monitoring and Assessment RouTine | A method that allows farms and companies in the food sector to assess their sustainability in a credible, transparent and comparable manner. SMART is the world's first tool, which is fully consistent with the SAFA-Guidelines and provides an efficient manner to apply them in practice.From The Research Institute of Organic Agriculture (FiBL). https://www.fibl.org/en.html |
| The 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. Coordinated through its Secretariat in Copenhagen, the GBIF network of participating countries and organizations, working through participant nodes, provides data-holding institutions around the world with common standards and open-source tools that enable them to share information about where and when species have been recorded. This knowledge derives from many sources, including everything from museum specimens collected in the 18th and 19th century to geotagged smartphone photos shared by amateur naturalists in recent days and weeks. https://www.gbif.org |
| Trends.Earth (formerly the Land Degradation Monitoring Toolbox) | A platform from Conservation International for monitoring land change using earth observations in an innovative desktop and cloud-based system. Trends.Earth allows users to plot time series of key indicators of land change (including degradation and improvement), to produce maps and other graphics that can support monitoring and reporting, and to track the impact of sustainable land management or other projects. Trends.Earth was produced by a partnership of Conservation International, Lund University, and the National Aeronautics and Space Administration (NASA), with the support of the Global Environment Facility (GEF). http://trends.earth/docs/en/ |
| UN Biodiversity Lab | A partnership between UNDP and UN Environment to provide high quality data for government representatives. It is a platform for building partnerships among data providers and data users to ensure that governments have access and capacity to use cutting-edge spatial data to make key conservation and development decisions. |