# Chapter 6. Data and indicator gaps on pressures and responses

Effective action for biodiversity requires improved knowledge of the state of, pressures on and policy responses for biodiversity. This chapter examines the status of data and indicators for biodiversity, highlighting how the current indicator suite does not effectively monitor progress towards the Aichi Targets. The chapter then discusses how new approaches to indicators in the post-2020 process, such as using headline indicators, could improve progress monitoring and the effectiveness of the new framework. Finally, the chapter explores the role of innovation and new technologies, such as artificial intelligence and remote earth observation, in creating new sources of data and indicators.

## 6.1. The need to improve data and indicators on biodiversity pressures and responses

A better understanding of the source and magnitude of pressures on biodiversity will help inform the design and implementation of effective responses (i.e. actions), whether by government, the private sector or households. Similarly, improving data and indicators on the types of responses implemented (at the national, regional and global scales), their level of ambition and their effectiveness, is crucial to tracking progress towards achievement of the intended biodiversity objectives. An improved set of biodiversity indicators would also enhance understanding of the mechanistic links between the state of biodiversity, the pressures on biodiversity and the responses (Box 6.1).

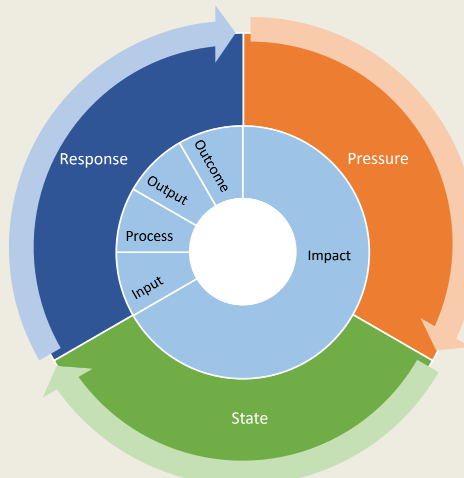
As the process of negotiating the post-2020 global biodiversity framework advances, taking stock of data and assessment efforts, understanding current limitations and devising ways to address gaps, is of paramount importance. The post-2020 process presents a crucial opportunity to create a more effective global biodiversity framework. Establishing more specific and measurable targets and indicators in the post-2020 framework will help improve the ability to monitor progress compared to the existing framework (Butchart, Di Marco and Watson, 2016[1]). Previous efforts to evaluate progress, such as the Global Biodiversity Outlook-4 (SCBD, 2016[2]), have struggled to identify sufficiently accurate and consistent data to track progress towards many of the targets in a comparable manner across countries (Tittensor et al., 2014[3]).

The post-2020 framework should include specific, measurable, ambitions, realistic and time-bound (SMART) targets to ensure that implementation and monitoring improve on the Aichi Targets. To support this, indicators for the post-2020 global biodiversity framework should be developed in tandem with targets in an iterative process. A first step is to take stock of the available data and indicators, and to identify the gaps.

### Box 6.1. The pressure-state-response model

The pressure-state-response model is a commonly accepted framework for identifying and structuring indicators. It distinguishes indicators of environmental pressures (both direct and indirect), indicators of environmental conditions (i.e. state) and indicators of societal responses (i.e. actions taken). Following the literature on the theory of change, response indicators can be further disaggregated into inputs (e.g. finance), processes (e.g. institutional changes), outputs (e.g. new legislation or policies), outcomes (e.g. increase in protected area coverage) and impacts (e.g. decline in the number of threatened species) (Figure 6.1). Thus, if the responses are effective (and lead to positive impacts in the last stage), they should manifest in an improved state of biodiversity.

**Figure 6.1. A schematic of the pressure-state-response indicator framework and how it relates to the theory of change**



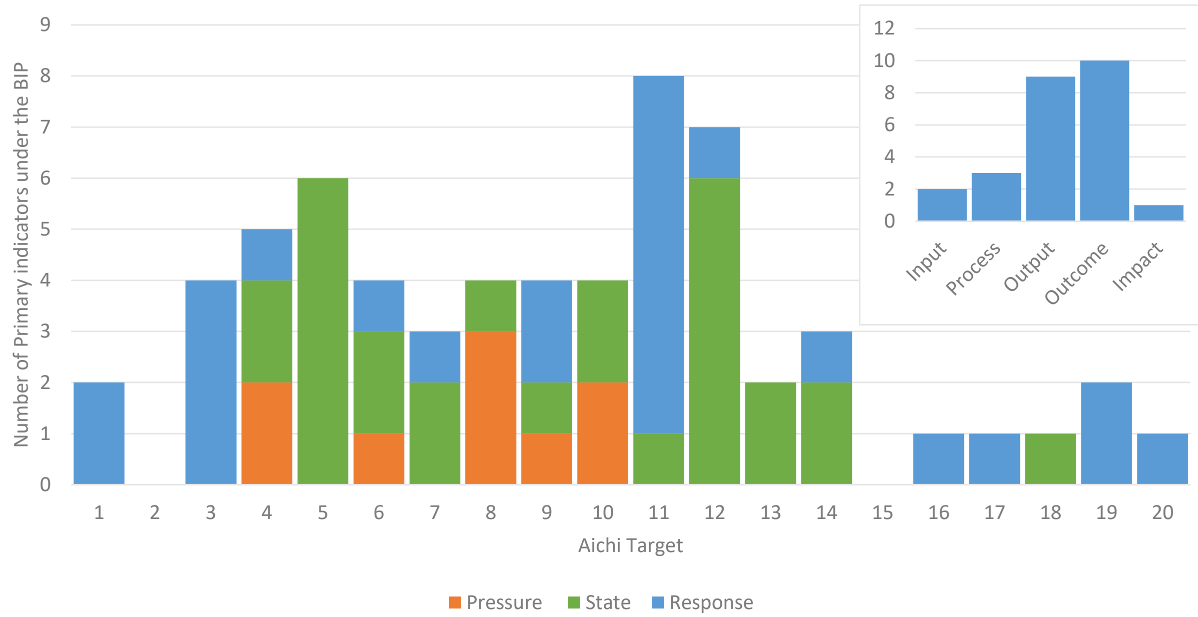

Source: OECD (2019[4]) *Summary Record from the OECD International Workshop on The Post-2020 Biodiversity Framework: Targets, indicators and measurability implications at global and national level.*

## 6.2. The current status of data and indicators to monitor pressures and responses

There have been large advances in the collection and analysis of biodiversity-relevant data. Remote-sensing technology now allows near-real-time monitoring of several key pressures globally, such as land-cover change in forest areas, fishing effort and forest fires (Global Forest Watch, 2019[5]; Global Fishing Watch, 2019[6]; VIIRS Active Fire, 2019[7]). Citizen-science data platforms, such as the Global Biodiversity Information Facility (GBIF) and the Ocean Biogeographic Information System, now contain well over 1 billion species occurrence records globally. Databases such as the OECD Policy Instruments for the Environment (PINE), which contains information on biodiversity-relevant economic instruments reported by more than 100 countries, and the World Database on Protected Areas, which maintains a record of the boundaries of protected areas globally, provide a rich landscape of data on policy responses. There have also been significant advances in the modelling of biodiversity responses to increasing anthropogenic pressure: indices such as the Biodiversity Habitats Index (GEO BON, 2015[8]) and the Biodiversity Intactness Index (Newbold et al., 2016[9]) can help assess changes in biodiversity over time and understand the impacts of policy responses.

Decision XIII/28 of the Convention on Biological Diversity (CBD) lists 98 indicative indicators to monitor progress towards the Aichi Targets, and 64 indicators are currently listed under the Biodiversity Indicators Partnership (BIP). The BIP covers a wide range of information, with 9 primary indicators (14%) on pressures, 28 (44%) on the state of biodiversity and 25 (39%) on the policy responses (Figure 6.2). [1]

## Figure 6.2. Number and types of primary indicators under the BIP to track progress towards the Aichi Targets




Note: Inset graph shows the type of response indicators across all targets. For a full list of the Aichi Targets see: www.cbd.int/sp/targets/. Indicator data accurate as of April 2019.

Information asymmetries exist across the Aichi Targets (and the environmentally relevant Sustainable Development Goals [SDGs], notably SDG 14 and SDG 15)[2]. For example, as of April 2019 there were no indicators to monitor progress towards Aichi Target 2 (on mainstreaming) and Aichi Target 15 (on ecosystem resilience and restoration). In addition, of the 25 response indicators available under the BIP, nearly a third relate to protected areas (i.e. Aichi Target 11).

Kuempel et al. (2016[10]) suggest that identifying a comprehensive set of indicators that are able to represent the changing state of a study system is an important step, which should be taken every time new targets are being defined. For each indicator, it is important to clarify whether it refers to conservation outputs (e.g. new legislation for protected areas [PAs]), outcomes (e.g. greater coverage of protected areas) or impacts (e.g. higher species abundance); to ascertain the availability of baseline data; and to determine the cost of collecting and maintaining new data. Table 6.1 provides further examples of possible comprehensive sets of indicators that could help to represent the changing state of a study system.

## Table 6.1. Examples of potential set of indicators for policy responses

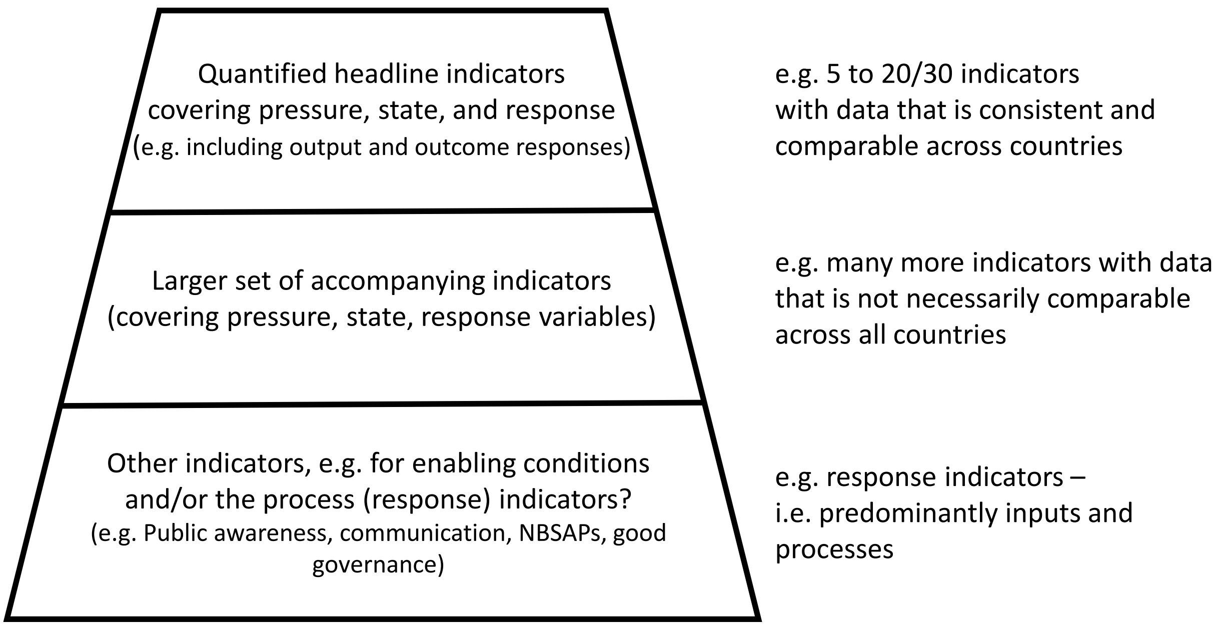
| Response theme | Input | Process | Output | Outcome | Impact |
|---|---|---|---|---|---|
| Protected areas | Increase in finance and staff for PAs | Systematic conservation planning | New legislation to increase PAs | Increase in PA coverage | Increase in species abundance |
| Sustainable fisheries | | Inter-Ministerial Committee on a Sustainable Ocean | Fisheries management plans | Increase in % of fish from sustainable sources | Reduction in the number of fisheries overexploited |
| Pesticide use | | Assessment of environmental impacts of pesticides | Reduction in pesticide subsidies; Introduction of pesticide taxes | Decline in pesticide use per hectare | Increase in farmland biodiversity (e.g. farmland bird index) |
| Sustainable agriculture | | Assessment of subsidy impacts on biodiversity | Farm-level biodiversity management plans | Increase in uptake of sustainable practices and habitat creation | Increase in farmland biodiversity (e.g. farmland bird index) |

Source: Authors

## 6.3. A proposal for headline indicators in the post-2020 framework

Under the CBD, indicators are currently arranged in a "flat" structure, suggesting all indicators are equally important. Some indicators may be more policy-relevant and important for tracking progress than others however. An alternative approach utilised by the OECD Green Growth Indicators is to identify a smaller set of *headline indicators* from the broader set of about 50 green growth indicators (OECD, 2017[11]).[3] The data for headline indicators must be consistent and comparable across countries. Figure 6.3 proposes a similar approach for the post-2020 biodiversity framework.

### Figure 6.3. Possible categories of indicators for the post-2020 biodiversity framework




Source: OECD (2019[4]) *Summary Record from the OECD International Workshop on The Post-2020 Biodiversity Framework: Targets, indicators and measurability implications at global and national level.*

### Table 6.2. Examples of possible headline indicators for policy responses

| Indicator | Data Provider | Status |
|---|---|---|
| Protected area coverage | World Database on Protected Areas | Available |
| Economic policy instruments: biodiversity-relevant taxes, fees and charges; tradable permits; positive subsidies. Data on payments for ecosystem services and biodiversity offsets under development. | OECD PINE database | Available |
| Potentially environmentally harmful support to agriculture | OECD PSE database | Available |
| Area under sustainable forest management | FAO | Under development |
| Extent of sustainable agriculture | FAO | Under development |

Note: FAO: Food and Agriculture Organization of the United Nations; PINE: Policy Instruments for the Environment database; PSE: Producer Support Estimate database.

## 6.4. Data and indicator gaps

### *6.4.1. Pressures*

Multiple anthropogenic pressures are exerted on biodiversity. These pressures include habitat loss and fragmentation (e.g. particularly from agriculture expansion), over-exploitation of natural resources, pollution, invasive alien species and climate change (Chapter 2).

Although the impacts of agriculture on biodiversity are generally well-known, comprehensive monitoring of these pressures and impacts is largely absent. Data on nutrient balances, pesticide sales and soil erosion have inconsistent coverage across countries. The Farmland Bird Index is the only direct indicator of agricultural biodiversity across many countries. However, data collection for this indicator relies on volunteers and is therefore vulnerable to changes in the availability of volunteer labour in both space and time, limiting its scope. Efforts to develop new indicators for agricultural biodiversity are underway in the European Union. Given the importance of agriculture to the global economy and environment, addressing this data gap is essential. Further, the impacts of agriculture and other forms of production are transmitted globally through international trade. However, detailed information on the biodiversity impacts embedded in the trade of many consumption goods is not available, complicating the implementation of effective policy solutions.

Pollution is a key pressure on both terrestrial and marine biodiversity (OECD, 2018[12]). While there is clear and increasing evidence of the impacts of plastic debris on marine species (see Chapter 2), the impacts of the bioaccumulation of micro plastics on ecosystem health, and, through consumption, on human health, are poorly understood (Koelmans et al., 2017[13]). Given the crucial role healthy marine and freshwater ecosystems play in the economy, the bioaccumulation of micro plastics and increasing plastic debris could have far-reaching implications throughout society. Similarly, data and indicators on pesticide pollution and its impacts and risks are not measured in a comprehensive manner. Better understanding the source and magnitude of pressures from pollution at local, national and regional levels is important.

Over-exploitation of biological resources is one of the major pressures on terrestrial, freshwater and marine biodiversity. Inappropriate management of fish stock, for example, can have severe impacts on biodiversity and the coastal communities that depend on it. But data are lacking: in 2016, the most recent year for which data are available, 29% of countries (12.8% of global catch) had not reported data to the FAO (FAO, 2018[14]). Furthermore, illegal, unreported or unregulated fishing catches are not included in these figures, and will likely have significant and currently unknown impacts on marine biodiversity. From a terrestrial perspective, over-exploitation is also a major driver of declines, again with considerable data deficiencies. Such is the case for trade in endangered species, where a lack of data on the flows of both legal (regulated by the Convention on International Trade in Endangered Species of Wild Fauna and Flora) and illegal trade is undermining the effectiveness of enforcement and demand-side measures aiming to address it (Symes et al., 2017[15]).

The development of satellite-based and other remote-sensing techniques has rapidly expanded understanding of land-cover change in recent years (e.g. through Global Land Cover, Community for Data Integration and Landsat) (Hansen et al., 2013[16]). Further development of such satellite-based and other techniques should also allow the assessment of land use. Information on the type and intensity of land use at high resolution will improve understanding of how the threats to biodiversity vary across space, and would help optimise investments in biodiversity (including conservation, sustainable use and restoration) through the management of associated economic trade-offs (Naidoo et al., 2006[17]). Better remote sensing of land cover and land use can also provide information on the changes in ecosystem fragmentation and the impacts on biodiversity (Haddad et al., 2015[18]).

Finally, the multiple pressures on biodiversity do not occur in isolation; instead, they act cumulatively or synergistically to heighten pressure (Chapter 3) (Barlow et al., 2016[19]; Symes et al., 2018[20]). This is particularly important for climate change and international trade, which have highly variable and complicated impacts on biodiversity (Marques et al., 2019[21]; IPCC, 2018[22]). Consequently, actions and investment for biodiversity must strive to account for the potential consequences of climate change (e.g. changes in weather patterns, species composition and phenological responses) that could undermine their impacts in the future. Understanding the mechanistic linkages between pressures on biodiversity and how investments in biodiversity can leverage these links to amplify their effectiveness is vital to designing cost-effective interventions.

### *6.4.2. Responses (i.e. actions)*

Despite progress in the actions put in place to address biodiversity loss, much about the policy responses remains unknown. For example, despite the wide-scale application and long history of protected areas (PAs), information regarding their effectiveness is lacking (Box 6.2). Data provided by countries to the OECD PINE database on the use of positive incentives (i.e. economic instruments) such as biodiversity-relevant taxes, fees and charges, tradable permits systems are also incomplete (Chapter 7).

Biodiversity mainstreaming[4] across both the public and private sectors is essential for effective action (Redford et al., 2015[23]). However, the plurality of institutions and policy frameworks at the national level makes the creation of internationally comparable indicators more challenging (OECD, 2018[24]). This is also true for the private sector (Chapter 4).

Linking policy responses to the pressures on biodiversity is key to effective interventions. Model-based indices, such as Biodiversity Habitats Index (GEO BON, 2015[8]) and the Biodiversity Intactness Index (Newbold et al., 2016[9]), have been developed to address this issue. However, the complicated modelling used to derive these type of indices is essentially a “black box”, making their interpretation challenging and undermining their utility for policy making.

## Box 6.2. Data and assessment of protected areas (PAs)

Achieving the "effectively and equitably managed, ecologically representative and well connected systems of protected areas" called for in Aichi Target 11 implies monitoring multiple dimensions of the PA systems, many of which are currently not monitored in a comprehensive way. For example, while some countries, such as European Union Member States and the United States, assess the status of biodiversity in protected areas regularly, this is not the case globally, particularly in hyper-diverse tropical countries. Table 6.3 summarises the various PA dimensions and the current status of data.

### Table 6.3. Potential dimensions of PAs that can be monitored and current status of data

| | Indicator status | Data source | Nationally-applicable | Globally-Comparable | Notes |
|---|---|---|---|---|---|
| Extent of PA | Tier 1 | World Database on Protected Areas, OECD | Yes | Yes | Accepted as indicator of progress towards Aichi Targets and SDGs |
| Connectivity | Tier 1 (terrestrial only) | Protected area connectedness index | Yes | Yes | Accepted indicator to track progress on Aichi Targets |
| Ecological representation | Tier 1 (terrestrial only) | Protected area representativeness index | Yes | Yes | Accepted indicator to track progress on Aichi Targets |
| Management effectiveness | Tier 2 | Global database on Protected Area Management Effectiveness | Yes | No | Data not collected routinely and multiple methodologies, making comparisons challenging |
| Ecological effectiveness | Tier 3 | n/a | No | No | Multiple ad-hoc studies available, but standard methods challenging, owing to multiple dimensions of effectiveness |

## 6.5. Addressing data and indicator gaps

Improving the coverage of existing databases, both in terms of geographic and informational range, is key for addressing data and indicator gaps. Some initiatives are underway, e.g. to expand the coverage of the OECD PINE database to include information on payments for ecosystem services and biodiversity offsets. Considerable opportunity exists to scale up data and assessments for biodiversity at a relatively low cost. Juffe-Bignoli (2016[25]) estimates that USD 114 million (US dollars) in investment is required to reach an initial baseline for four globally important biodiversity-knowledge products[5] (including the International Union for Conservation of Nature [IUCN] Red List of Threatened Species), a fraction of the USD 5-7 billion required to monitor global climate for the United Nations Framework Convention on Climate Change (WMO, 2010[26]). Ongoing developments in environmental accounting, emerging technologies and innovation (Box 6.3) provide further opportunities for filling data gaps, and improving the quality and efficiency of data collection. Finally, the development, application and harmonisation of methodologies and standards to measure the biodiversity impacts embodied in trade, such as the UNEP/SETAC (2016[27]) Life

Cycle Assessment guidance and the EU Environmental Footprint standards (EC, 2013[28]) is helpful in this regard.

Conversely, mobilising national data-collection efforts to track progress internationally would benefit from better co-ordination of the national agencies responsible for data collection with international data aggregators, such as the OECD PINE database and the GBIF. Many countries (including in the Group of Seven [G7]) have extensive biodiversity-monitoring programmes (e.g. the UK Biodiversity Indicators programme and the US National Parks Service Vital Signs monitoring programme). Sharing best-practice insights from these programmes – possibly through peer learning, to facilitate knowledge exchange between national-level institutions – could benefit countries with less-developed programmes.

Finally, a commitment to open data by all relevant institutions (where possible), both nationally and internationally, is essential to address data gaps, enhance accountability, and improve the design and implementation of policies for biodiversity (OECD, 2019[29]). A powerful example of the impacts open data can have is the NASA Earth Observation Systems Data and Information Systems, which provides free access to over 11 000 unique data products. These data products now underpin many of the global-scale indicators available today. Further initiatives to make data open source will likely help close data gaps without the need for additional expensive data collection by ensuring more effective use of existing data.

## Box 6.3. Role of innovation in addressing data gaps

The rapid development of technology has led to an explosion in the volume and types of data that can be collected across many sectors of the economy, society and environment (OECD, 2019[29]). Biodiversity is no different. Several novel, emerging or developing technologies have the potential to support traditional data collection by diversifying the types of data that can be collected and the way existing data can be used by the public sector, the private sector and private individuals. In some cases, these impacts are being felt already. Emerging artificial intelligence techniques, for example, combined with remote data collection from camera traps and acoustic monitoring, has already proved a powerful tool for identifying species and even individual animals (Kwok, 2019[30]). Further, nanopore DNA sequencing can be used fight illegal wildlife trade and block chain technology to provide end-to-end transparency of supply chains, while mobile phone applications have already increased role of citizen scientists in monitoring biodiversity. Finally, the emergence of new technologies represents a major opportunity for new business: Earth observation from space, for example, was worth USD 7.5 billion a year in 2015 (PwC, 2019[31]). The G7 can play a key role in leading the development and implementation of innovations for biodiversity (see Annex F for more information).

### Table 6.4. Examples of innovation for biodiversity

| Technology | Data generated | Innovation and availability | Data Gap addressed | Key beneficiaries | Caveats |
|---|---|---|---|---|---|
| Nanopore DNA sequencing | DNA sequence data | Allows for the manufacture of desk-top DNA sequencers which are highly mobile, rapid and much lower cost than more traditional techniques. Available now, but more research needed for full application | Genetic diversity, microbial diversity, monitoring and enforcement of wildlife trade (through sample identification) | Public sector, Private sector | Complementary DNA library and barcodes need to be developed to utilise effectively |
| Block chain | NA | The structure of a block chain database, should allow for the entire supply chain of a product to be accessible by the end-user, be that the consumer or retailers. Currently available | Supply chain sustainability, transparency of product origin. Useful for food, beverages, timber and other wildlife products | Public Sector, Private sector, Individuals | Potentially high energy use and not currently mobilised |
| Artificial intelligence (AI) and machine learning | Various | Remote sensing networks generate vast quantities of data (for example camera traps and acoustic monitoring). AI techniques can process this data into useful information which can them be used to monitor many dimensions of biodiversity (species occurrence, population dynamics, habitat disturbance) | State, pressures and responses | Public Sector, Private sector, Individuals | Availability of training data is low for many cases, creating training libraries is labour intensive |
| Citizen led data collection | Various | Democratises biodiversity data collection, currently utilised widely, most notably though GBIF. Allows for individual engagement with biodiversity | State of biodiversity | Public Sector, Individuals | Data generated is difficult to use and biased, requires more sophisticated analytical techniques than currently available (better developed AI for example) |

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## Notes

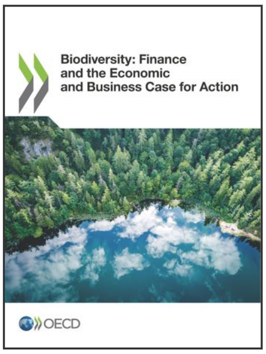
[1] Note that the data providers also assign categories themselves, resulting in 23 state, 19 pressure and 20 response indicators.

[2] 68% (63) of the environmentally relevant SDG indicators cannot be measured due to a lack of data (UNEP, 2019[32]).

[3] The OECD Core Set of Environmental Indicators also uses a similar approach, where ten key indicators have been endorsed by national ministries.

[4] The Global Environmental Facility defines mainstreaming as "The process of embedding biodiversity considerations into policies, strategies and practices of key public and private actors that impact or rely on biodiversity, so that it is conserved and sustainably used both locally and globally."

[5] The IUCN Red List of Threatened Species, the IUCN Red List of Ecosystems, Protected Planet and the World Database of Key Biodiversity Areas.

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