



Institute
and Faculty
of Actuaries

Biodiversity & Nature Related Risks for Actuaries: An Introduction

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**Pathways to
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1 About this report

This report is an introduction to biodiversity and nature related risks for actuaries in all fields of work. It provides an overview of current topics and industry developments and highlights how they are relevant to actuarial work. You can read this paper as a whole or skip straight to the section you are interested in.

“Introduction” covers key terms, gives an overview of the current scientific consensus and outlines the international policy response to help actuaries understand the external economic environment within which they are operating.

“Dependencies on biodiversity & nature” outlines the benefits humans obtain from biodiversity and nature. This helps actuaries understand the economic sectors and activities which are most dependent on biodiversity and nature and explores how risks may materialise for these companies if biodiversity and nature are disrupted.

“Impacts on biodiversity & nature” outlines the main human activities that drive biodiversity and nature loss. This helps actuaries explore the economic activities that drive the materialisation of associated risks and identifies potential levers for taking action to reverse biodiversity and nature loss as well as areas likely to be impacted by future regulation.

“Implications for actuaries” is split into several sections covering interactions with other sustainability topics and economic impacts followed by implications for GI liabilities, Life & Health liabilities and investors.

“Regulatory & reputational risks” outlines the reputational considerations, followed by an overview of both mandatory and voluntary financial services industry initiatives in relation to biodiversity and nature.

2 Introduction

This section covers key terms, then gives an overview of the current scientific consensus and finally outlines the international policy response. This helps understand the external economic environment actuaries are operating within.

2.1 Summary of key concepts and terms

Biodiversity is defined as “the variability among living organisms from all sources.” Biodiversity includes diversity within species, between species and ecosystems and encompasses genetic diversity, phenotypic diversity and changes in abundance over time and space²⁸. Nature is broader and includes all features, forces and processes created at the same time as earth such as water, geology and climate^{70,71}. An ecosystem is a community of living organisms (plants, animals, fungi, microbes) plus the non-living parts of their environment (energy, air, water) all interacting as a system.²⁸ Biodiversity is a characteristic of ecosystems that increases resilience to shocks and reduces risks to the ecosystem services upon which we rely².

Whilst biodiversity, ecosystems and nature are distinct concepts they are closely related. This guide covers both biodiversity specific information as well as the broader topic of nature. The wide array of international and financial system initiatives considered may relate to one or both and may use terms interchangeably, something also reflected in this guide. This is particularly relevant when considering risk classification, where the financial sector tends to use the broader term “nature related risks” to encompass risks that emerge due to biodiversity loss and disruption of ecosystems as well as broader issues such as water, geologic & climatic events.

A longer glossary of related concepts and terms is provided in [Appendix A](#), links to the appendix are provided whenever these extended concepts are referred to in the main report.

2.2 Nature related Risks

As with climate related risks, nature related risks act to amplify risks in an organisation due to systemic impacts that have multiple transmission channels to the financial sector. Nature related risks are categorised into physical, transition and liability risks (with liability risks sometimes considered a subset of transition risks).^A

Nature-related physical risks are a direct result of an organisation’s dependence on nature. They materialise due to climatic or geological events or when ecosystems (living or non-living parts) are disrupted. Organisations and communities that depend on these ecosystems and the services they provide are then affected. These risks can be acute or chronic, are usually highly location specific and are often associated with climate related physical risks. Examples of nature related physical risks would be the decline in insect pollinators leading to reduced pollinator-dependent crop yields or mangrove loss leading to increased exposure to flooding and storm surge.

Human activities drive the emergence of physical risks, for example forest and wetland clearance for commercial purposes increases the physical risks to an area from sea level rise and flooding. Another example is the disruption to natural habitats and ecosystems that occurs due to human activities like deforestation, livestock production and building settlements which drives the emergence of zoonotic diseases, pandemics and antimicrobial resistance. The systemic nature of these risks mean widespread impacts can emerge regardless of location. This is discussed further in [section 4.1](#).

^A Definitions in this section are taken from the Taskforce for Nature Related financial disclosures³²

Nature-related transition risks are risks that result from a misalignment between an organisation's or investor's strategy and management and the changing regulatory, policy or societal landscape in which it operates. Developments aimed at halting or reversing damage to nature, such as government measures, technological breakthroughs, market changes, litigation and changing consumer preferences can all create or change transition risks.

Liability risks are often considered a subset of transition risks and refer to risks that arise from litigation being taken against companies that adversely impact nature. For insurers, these risks can manifest as liabilities on policies such as Director & Officers cover, general liability, professional indemnity and Errors and Omissions (E&O) insurance. They could also arise from direct litigation against those providing financing or underwriting services to companies that adversely impact nature.

Nature related risks have a number of characteristics which make them more complex than their climate related counterparts:

- 1) There is no single measure to quantify nature related impacts (compared to the amount of greenhouse gas (GHG) emissions for climate change).
- 2) The overall dependency and impact on nature depends both on the type of activity occurring *and* the location at which it occurs. For example, activities considered benign in terms of nature impacts, may be significant if they take place in biodiversity hot spots or protected areas, whereas other activities may have detrimental impacts regardless of where they are carried out. This is explored in [section 3](#).
- 3) Biodiversity is unique to a geographical location, if it is damaged in one area it is not easily re-established somewhere else. This means the concept of "offsetting" impacts is more challenging than with GHG emissions.

2.3 Key scientific evidence

The Intergovernmental Science Policy platform on Biodiversity and Ecosystem services (IPBES) is an independent intergovernmental body that brings together the latest scientific data on biodiversity and ecosystem services. IPBES produce regular assessment reports on biodiversity and ecosystem services through a rigorous process that brings together global experts in response to requests for reports on specific topics²³.

Nature is deteriorating worldwide due to human drivers¹

Nature provides benefits to humans that underpins our existence. Despite this, human activity is significantly altering nature with most indicators of ecosystem services and biodiversity in decline¹. Significant impacts are found across 75% of the global land surface and 66% of global ocean area as well as the loss of over 85% of wetlands¹.

Animal and plant populations are in decline, with around 25% (approximately 1 million) of species threatened with extinction¹ and an average of 69% decline in vertebrate species populations between 1970-2018²². The rate of this change over the past 50 years is unprecedented on human timescales¹. Biodiversity loss undermines the resilience of many agricultural systems to threats such as pests, pathogens and climate change and poses a serious risk to global food security¹.

Drivers of Nature loss have accelerated over the last 50 years¹

The drivers of biodiversity loss result from human behaviours, production, and consumption. For example, in the last 50 years the global economy has quadrupled demand for energy and raw materials. These drivers in order of impact are:

- Land and Sea Use change
- Resource Extraction
- Climate change
- Pollution
- Invasive alien species

These are explored in more detail in [section 3.2](#).

Climate change and biodiversity loss are inextricably connected such that resolving either issue requires consideration of the other^{3,4,16}

Well-functioning ecosystems are carbon stores and help regulate the climate. Activities that cause nature loss can release stored carbon dioxide (CO₂) into the atmosphere and impair the ability of nature to function as a carbon sink. Climate change is a key driver of biodiversity loss as temperature rise, sea level rise, extreme events and ocean acidification disrupt natural habitats. For example, deforestation is contributing to climate change which in turn drives further forest destruction through moisture stress and wildfires¹⁶ and climate driven extreme heat events have caused mass mortality events for ocean and land based species including extinctions.⁷⁴ Ocean absorption of carbon dioxide has led to acidification which hinders the ability of calcifying organisms (such as krill) to maintain their calcium carbonate skeletons and shells⁷⁴ disrupting biodiversity. It also leads to increased production of dimethyl sulphide (DMS) by phytoplankton causing further warming due to reduced reflection of solar radiation⁷⁴.

Human induced environmental changes that drive biodiversity loss and climate change also drive infectious disease emergence¹⁷

The risk of pandemics is increasing due to human activity¹⁷. Activities such as agricultural and urban expansion and wildlife trade and consumption drives biodiversity loss, disrupts ecosystems and increases contact points between wildlife, livestock and humans creating pressures for diseases to both emerge and spread. Climate change further disrupts ecosystem dynamics and alters geographical range of wildlife populations including disease vectors such as mosquitos and ticks¹⁷. Around half of the species assessed globally have shifted poleward or to higher elevations on land⁷⁴ and the incidence of vector-borne diseases has increased (both from range expansion and increased reproduction of disease vectors).⁷⁴

Tipping points in the earth's system are well recognised^{75,76, 77} and are closely linked with biodiversity, climate change and human outcomes^{59,78}

Tipping points represent thresholds that when crossed move a system into a new state leading to widespread impacts. They are driven by positive feedback loops that become self-perpetuating beyond the threshold⁶⁰ meaning they are often irreversible. The following represents the biosphere components of recognised earth system tipping points⁷⁹ and demonstrate the close links with climate change:

1. **Boreal Forest** *Southern dieback* occurs due to climate change driven changes in the water cycle, more frequent fires and bark beetle outbreaks. As forests are replaced by steppe or prairie which are grass dominated, carbon is released driving further warming. *Northern expansion* of the boreal forest driven by warming temperatures replaces reflective snow covered surfaces (that reflect solar radiation) with darker forest and thus accelerating arctic warming. These shifts also represent huge changes to habitats and disruption to ecosystems leading to biodiversity loss.
2. **Coral reef** ecosystems have some of the highest biodiversity worldwide as well as protecting the coastline and supporting tourism. Climate change driven ocean acidification and warming ocean temperatures drive coral bleaching and shift coral ecosystems to sponge or algae⁵⁹.
3. **Sahel vegetation & the West African monsoon** are closely linked with increasing rainfall leading to increased vegetation and vice versa⁷⁹. This could lead to changes in vegetation (and hence habitats and biodiversity) in the Sahel region.
4. **Amazon Rainforest** feedbacks between more frequent fires and more intense drought could shift large areas of the rainforest to savanna or seasonal forest⁷⁹. This has widespread changes on biodiversity in the area as well as impacts on global climate with increasing carbon emissions accelerating climate change

In the examples above, biodiversity loss is either directly driven by climate change or there are feedbacks between climate change and biodiversity loss, however, biodiversity loss can be a direct driver of tipping points with species diversity, species abundance or a few functionally important species playing a key role⁵⁹. This could include for example overhunting, fragmentation of ecosystems or invasive alien species leading to collapse in population numbers or even extinctions. Often multiple dynamics are at play at the same time.

Current evidence suggests that major biodiversity transformations will occur at low levels of global warming (below 2°C) including near total loss of coral reefs⁶⁰ and destruction of many coastal ecosystems.⁵⁹ Each incremental increase in warming increases the likelihood of passing further tipping points which emphasises the need to pursue efforts to limit any increase.

Indigenous Peoples and Local Communities (IPLCs) are vital custodians of the world's remaining natural landscapes. As such, achieving the ambitious goals and targets in the post-2020 global biodiversity framework will not be possible without the lands and territories recognised, sustained, protected and restored by IPLCs⁹³

At least 32% of the global land and inland waters is owned or governed by IPLCs⁹³, a large proportion of which is particularly important for biodiversity, for example [key biodiversity areas](#), protected areas or areas with very low human intervention¹. Indigenous peoples and local communities (IPLCs) depend on nature for subsistence, livelihoods and health¹ with the majority of IPLC lands being in good ecological condition, highlighting that they are better managed and consistent with biodiversity conservation⁹³.

Whilst nature managed by IPLCs is deteriorating less rapidly than elsewhere it is still facing pressure from resource extraction, deforestation, agriculture and some climate change mitigation programmes¹. This leads to negative impacts on the health of these communities, loss of traditional livelihoods, local knowledge and management practices. Recognition of the rights of IPLCs and their inclusion in designing and implementing solutions to support global biodiversity goals is imperative.

2.4 International response

The Convention on Biological Diversity⁵ (CBD) is the international agreement aimed at the conservation and sustainable use of biodiversity and has been ratified by 196 nations

The Convention on Biological Diversity has 3 aims:

- The conservation of biological diversity
- The sustainable use of the components of biological diversity
- The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The Conference of Parties (COP) is the governing body of the CBD and currently meets every 2 years to advance the goals of the agreement. The Convention was opened for signature at the Earth Summit in Rio de Janeiro on 5 June 1992 and entered into force on 29 December 1993. All United Nations (UN) member states except the USA have ratified the convention. There are two protocols to the CBD:

- The **Cartagena protocol** came into force in Sept 2003 and aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity, taking also into account risks to human health³⁰.
- The **Nagoya protocol** came into force in October 2014 and aims to ensure the sharing of the benefits arising from the use of genetic resources in a fair and equitable way³¹. Equitable access to genetic resources and digital sequence information (DSI) is important to ensure that communities in which genetic material is sourced benefit from its use – for example when used for development of pharmaceuticals. Countries agreed at COP 15 to develop a multilateral benefit sharing mechanism for DSI, including a global fund although the exact details are still to be agreed⁶.

To date global action on biodiversity has not delivered against targets set

Previous biodiversity targets (known as the Aichi targets) had a target date of 2020 but none of the 20 targets were fully met. Current negative trends in biodiversity undermine progress towards 80% of the targets underlying the Sustainable Development Goals relating to poverty, hunger, health, water, cities, climate, oceans and land (Sustainable Development Goals 1, 2, 3, 6, 11, 13, 14, and 15)¹.

At COP 15 in December 2022 a new set of global biodiversity goals were agreed known as the Kunming-Montreal Global Biodiversity Framework (GBF)

The GBF⁹ aims to “Halt and reverse biodiversity loss by 2030” through its 4 goals and 23 targets. This includes targets to restore 30% of degraded ecosystems by 2030 and the effective conservation and management of 30% of land and 30% of oceans by 2030. The framework recognises that climate change must be addressed as part of the solution and “acknowledges the important roles and contributions of indigenous peoples and local communities as custodians of biodiversity and partners in the conservation, restoration and sustainable use” and states that its “implementation must ensure their rights, knowledge, including traditional knowledge associated with biodiversity, innovations, worldviews, values and practices of IPLCs are respected, documented, preserved with their free, prior and informed consent”.

Box 1 provides a summary of the GBF and highlights the 3 goals directly related to finance. This reflects recognition by the international community that financial institutions have a role in delivering globally agreed biodiversity goals. At the same time central banks^{9,10} and regulators¹² have recognised biodiversity and nature loss as drivers of financial risks with increasing pressure^{26,55} for financial institutions to identify, manage and disclose their impacts and dependencies on nature and set targets^{39,55} to reduce them.

Box 1: Summary of Kunming-Montreal Global Biodiversity Framework

The global biodiversity framework aims to halt and reverse biodiversity loss by 2030^{6,7}

Goal A <ul style="list-style-type: none"> Maintain/enhance/restore ecosystems Halt human induced extinction Maintaining genetic diversity 	Goal B <ul style="list-style-type: none"> Sustainable use of biodiversity Ecosystem services are valued, maintained and restored
Goal C <ul style="list-style-type: none"> Equitable sharing of the benefits from the use of genetic resources including IPLC's Traditional knowledge is protected 	Goal D Adequate implementation including financial resources, capacity building, technical and scientific cooperation.

Target	Description
1	Effective management of land- and sea-use change, loss of highly important biodiverse areas close to zero by 2030
2	Effective restoration of 30% of degraded ecosystems by 2030
3	Effective conservation and management of 30% of land and 30% of oceans by 2030
4	Halt human-induced extinctions and maintain and restore genetic diversity
5	Sustainable use, harvesting and trade of wild species
6	Mitigate or eliminate the impacts of invasive alien species, reduce the rates of establishment of invasive species by 50% by 2030
7	Reduce pollution risks and impacts from all sources by 2030, reduce the overall risk from pesticides by half
8	Minimise the impacts of climate change and ocean acidification on biodiversity
9	Ensure sustainable use and management of wild species, while protecting customary use by Indigenous peoples
10	Sustainable management of areas under agriculture, aquaculture, fisheries and forestry
11	Restore and enhance ecosystem function through nature-based solutions and ecosystem-based approaches
12	Increase the area and quality of urban green and blue spaces
13	Fair and equitable sharing of the benefits arising from the use of genetic resources
14	Integration of biodiversity into policies and development across all sectors and aligning fiscal and financial flows with the goals and targets
15	Enable businesses, in particular financial institutions to monitor, assess and disclose their impacts on biodiversity
16	Encourage sustainable consumption, including by reducing food waste by half by 2030
17	Strengthen capacity for biosafety measures and ensure benefits-sharing from biotechnology
18	Phase out or reform harmful subsidies in a just way, reducing them by \$500bn by 2030
19	Substantially increase financial resources, mobilise \$200bn per year by 2030 from all sources, including \$30bn from developed to developing countries
20	Strengthen capacity-building and technology transfer
21	Integrated and participatory management, including the use of traditional knowledge
22	Equitable representation and participation of Indigenous peoples and local communities
23	Ensure gender equality in the implementation of the framework

Targets directly referencing finance are highlighted in green

3 Dependencies and impacts on biodiversity and nature

[Section 3.1](#) outlines the benefits humans obtain from nature and helps understand the economic sectors and activities that are most dependent on biodiversity and nature. [Section 3.2](#) explores the human activities that drive nature and biodiversity loss whilst [section 4](#) discusses how these dependencies and impacts translate into risks for the financial sector, including risks that are systemic in nature.

3.1 Dependencies on biodiversity and nature

Human society and economies are embedded in nature and dependent upon it

Nature performs a variety of functions that generate benefits to people. These benefits are known as ecosystem services^B, and they underpin our economies, societies, health and food systems and give rise to physical risks if they are undermined.

Provisioning services are goods obtained from ecosystems such as food, raw materials, freshwater, energy and medicines. Around 70% of cancer drugs¹ and 75% of antimicrobials¹⁷ are derived from nature.

Regulating services moderate natural processes and keep the natural world in balance. This includes pollination, carbon storage, waste decomposition, biologic control (predator-prey cycles) and regulating local climate and air quality. Animal pollination is critical for over 75% of food crops¹.

Cultural Services are the non-material benefits obtained from ecosystems such as recreational, aesthetic, educational, spiritual and cultural experiences.

Supporting/Maintenance services are activities that support other parts of ecosystems⁷⁰ and include the maintenance of genetic diversity, biomass production, habitat provision, photosynthesis, soil formation and the water cycle.

The World Economic Forum (WEF) estimates that \$44 trillion or over 50% of global GDP is moderately or highly dependent on nature⁸ and ranks biodiversity loss and ecosystem collapse as its 4th greatest risk over a 10 year time horizon in its 2023 global risks report

The Taskforce for Nature Related financial Disclosures (TNFD)⁸⁰ define dependencies as “aspects of ecosystem services that an organisation or other actor relies on to function”. The degree to which an organisation or individual is dependent on nature is a function of both the characteristics of the activity and the location of the activity. The characteristics of an activity will determine its reliance on ecosystem services (what ecosystem services it depends on and to what extent), whilst the resilience of those ecosystem services (the capacity for those ecosystems to continue to provide a flow of benefits) will vary by geographical location⁴². Assessing dependencies requires spatial location data, to identify ecosystem types and their condition at the location of operations, using measures such as the

^B Categorisation of ecosystem services mirrors the approach used in the Millennium Ecosystem Assessment.

Ecosystem Integrity Index.⁴² Ecosystems that are more degraded will have a reduced capacity to provide services. Assessing reliance involves exploring the significance of a loss of that ecosystem service to the production process.

Identifying how deterioration in the underlying ecosystem service(s) might impact a business allows us to understand how risks may materialise across the economy both directly and through supply chains. Although a business may not intrinsically be reliant on nature to operate, it may be affected by virtue of its geographical location – for example, a business premises located along a stretch of coastline protected by coral reefs or mangroves will face higher risks from storm surge and flooding if those ecosystems are destroyed.

The table below shows the economic sectors identified as having the highest dependencies on nature^C due to the characteristics of their activities from two sources: the UN Environment Programme Finance Initiative (UNEP-FI) “Beyond Business as Usual”⁸¹ and the World Wildlife Fund (WWF) Biodiversity Risk Filter (BRF).^{D,14}

Sectors highlighted green appear on both high dependency and high impact lists. [Section 3.2](#) has a similar table for impacts.

Economic Sectors with high dependencies on biodiversity & ecosystem services

WWF	UNEP-FI
Paper & Forest Product Production	Forest Products
Fishing and aquaculture	
Agriculture (plant products)	Agricultural products
Agriculture (animal products)	
Hospitality Services	
Food & Beverage Production	Brewers
	Distillers & Vintners
Land Development & Construction	
Water utilities / Water Service Providers	Water Utilities
Metals & Mining	
Oil, Gas & Consumable Fuels	
	Apparel, Accessories & Luxury Goods
	Electric Utilities
	Independent Power Producers & Energy Traders
	Renewable Electricity
	Textiles

These can provide a useful starting point for sectors to prioritise for further scrutiny, however they should be considered alongside geospatial information^E and an assessment of financial flows and exposures^F. Methodology approaches which account for the differences between the lists are discussed in [Appendix B](#).

^C The Finance for Biodiversity Foundation paper only covers impacts

^D The overall rankings were calculated by the author by summing the industry sector dependency and impacts scores across all BRF indicators, using the following WWF source: <https://riskfilter.org/biodiversity/inform/industry-overview>

^E For example, agricultural products highly dependent on water, face greater risks in terms of their dependency on water if they are based in locations that face water shortages

^F Alongside the issues described in this section the materiality of a sector to a financial services firm will also depend on their exposure to the sector – for example financial services firms with large exposures to sectors with moderate biodiversity dependencies may choose to prioritise these sectors rather than their exposure to companies with high dependencies but to which they have limited exposure.

3.2 Impacts on biodiversity and nature

Human activities driving land and sea use change, resource extraction, climate change, pollution and invasive alien species are driving biodiversity loss^G and these drivers have accelerated over the past 50 years^{1,15}

Land use & sea-use change

75% of total land surface and 40% of the ocean area are significantly altered¹⁵ and 54% of wetland area has been lost since 1900 with 87% lost in the last 300 years⁸³. By 2050 it is estimated that less than 10% of earth's land surface will remain free from direct human impact⁸³. *Agricultural expansion* is by far the most widespread form of land cover change¹⁵, with areas cleared for cropping and animal husbandry. This is driven by demand for meat based diets as well as the expansion of tree plantations. The largest percentage change in land use comes from *urbanisation* with the total area of cities doubling from 1992 to 2015¹⁵. Remaining land cover is increasingly *fragmented*, driven by activities such as logging, agricultural expansion, fire and mining. *Intensification of agriculture, fisheries, aquaculture and forests* has resulted from technological advances at the expense of ecosystems and soil and water pollution. *Land degradation* such as erosion, vegetation loss, acidification and acidity has multiple drivers including agricultural intensification, crop irrigation, pollution and climate.

Resource Extraction

Resource extraction is driven by global demand for materials for construction and industry, fossil fuels and minerals as well as living organisms from agriculture, forestry and fishing. Freshwater withdrawals are mainly used for agriculture, industrial use and human consumption. Freshwater withdrawals have widespread impacts on nature including water and food security, altering hydrological regimes and land degradation as well as social impacts such as conflict¹⁵.

Climate change

Mean global temperature rise is now 1.2°C above pre-industrial levels⁸⁴ with most land regions warming faster than the average whilst most ocean regions warm slower¹. Increased GHG concentrations lead to increased land and ocean temperatures, increased extreme weather and ocean acidification and oxygen depletion. These changes negatively impact on biodiversity³ with the ability of many ecosystems to adapt being exceeded by unabated climate change.

Temperature rise causes thermal stress and mass mortality events across land and oceans⁷⁴, coral bleaching and melting of sea and land ice as well as changes in precipitation and extreme weather events that negatively impact ecosystems. *Sea level rise* changes habitats with low lying cities, beaches and wetlands becoming more vulnerable to flooding and land loss. *Ocean acidification* disrupts coastal and marine organisms which impacts their ability to function as a store of carbon in turn further impacting climate change. Acidification reduces calcifying organisms' ability to maintain their calcium carbonate shells as well as contributing to coral bleaching.

On the other hand, land and ocean ecosystems are rich in both carbon and species. Destroying these areas through land and sea use change releases stored carbon into the atmosphere, contributing to GHG emissions and impairing their ability to function as carbon sinks. For an idea of scale, ocean and land ecosystems store c.60% global GHG emissions per year¹. Protecting these areas is therefore important for both climate change mitigation and protecting biodiversity.

As well as benefits for climate change mitigation, restoring nature is important for climate change adaptation as natural structures such as coral reefs and coastal wetlands afford protection from extreme weather events such as storm surge and flooding.

^G Presented here in order of impact

Pollution

Pollution is associated with transport & energy systems as well as commercial and household activities. *Airborne pollutants* such as nitrous oxide and sulphur dioxide have negative impacts on human and environmental health with negative impacts associated with *noise* pollution also increasingly recognised. *Water pollutants* include raw sewage, industrial and agricultural runoff which often contain pathogens, heavy metals and pharmaceutical residues. *Solid wastes* include electronic waste, plastics and landfill all of which produce adverse environmental impacts.

Invasive Alien species (IAS)

IAS are species introduced outside their natural past or present geographical range whose introduction then threatens biodiversity²⁸. Major drivers of IAS are expansions of trade networks, higher human mobility, habitat degradation and climate change¹⁵ (which alters species geographic range)^{17,74}.

Economic activities which drive impacts on biodiversity and nature undermine the ecosystem services upon which we all depend. The Dutch National Bank puts global economic damages from biodiversity loss at \$2-4.5 trillion per year²⁵

The Taskforce for Nature Related financial Disclosures (TNFD)⁸⁰ define impacts as “changes in the state of nature which may result in changes to the capacity of nature to provide social and economic functions”. As for dependencies, the impact an organisation or individual has on nature depends on both the characteristics of the activity (what pressure it applies to nature and ecosystem services) and the location at which it is carried out (e.g. irreplaceability of nature at that location, species extinction risk, ecosystem collapse risk).

A common metric for assessing impacts at the ecosystem level is “condition adjusted area” which assesses the condition of an ecosystem vs its “intact” reference state reducing it to account for the impact^{H, 42}.

*Condition adjusted area = Area * (1- remaining condition)*

Business activities can be evaluated to estimate the reduction in condition adjusted area caused by the activity. The [Ecosystem Integrity Index](#) is a best practice metric for calculating the “remaining condition” part of the condition adjusted area⁴².

This is considered alongside “location significance” measures which consider the importance of environmental assets for the ongoing provision of ecosystem services at a particular location. For example, geographical locations such as [Key Biodiversity areas](#), [World heritage sites](#), [IUCN protected areas](#) are highly significant and warrant extreme caution regardless of activity.

^H For example, if an area has 100 hectares of forest but only half is intact then it is equivalent to having only 50 hectares of forest in terms of biodiversity value⁴².

Business activities with high impacts on nature can give rise to transition risks for these companies as well as driving physical risks for everyone. The table below shows the economic sectors identified as having the highest impacts on nature¹ due to the characteristics of their activities from the following 3 sources; UN Environment Programme Finance Initiative (UNEP-FI) “Beyond Business as Usual”⁸¹, the World Wildlife Fund (WWF) Biodiversity Risk Filter (BRF)^{J,14} and the Finance for Biodiversity Foundation briefing paper.⁸⁸ Sectors highlighted **green** appear on both high dependency and high impact lists. Methodology approaches account for differences between the lists and are explained in [Appendix B](#).

Economic Sectors with high impacts on biodiversity & ecosystem services

WWF	UNEP-FI	Finance for Biodiversity
Agriculture (animal products)	Agricultural products	Food Products
Agriculture (plant products)		Oil, Gas & Consumable Fuels
Metals & Mining	Mining (Aluminium, Coal & consumable fuels, Copper, Diversified Metals & Mining, Gold, Precious metals & minerals, Silver)	Chemicals
Oil, Gas & Consumable Fuels	Oil & Gas Exploration & Production	Consumer Staples, Distribution & Retail
	Oil & Gas Storage & Transportation	Metals & Mining
	Oil & Gas Drilling	Pharmaceuticals
Land Development & Construction		Health Care Providers & Services
Paper & Forest Product Production		Automobiles
Transportation Services	Marine Ports & Services	Electric Utilities
	Airport Services	Trading Companies & Distributors
Electric Energy Production – Hydropower		
Electric Energy Production - Combustion (Biomass, Coal, Gas, Nuclear, Oil), Geothermal Energy		
Fishing and aquaculture		
	Distribution (Distributors, Food distributors, Health Care distributors, Technology distributors)	

As highlighted in [Section 3.1](#), whilst these lists can provide a useful starting point for prioritisation, they should be considered in the specific business context alongside geospatial information, financial flows and exposures. Since these activities generate externalities for the whole economy and society by undermining the ecosystem services upon which we all depend, they may form good starting points for engagement and stewardship activity for financial services companies.

¹ The Finance for Biodiversity Foundation paper only covers impacts

^J The overall rankings were calculated by the author by summing the industry sector dependency and impacts scores across all BRF indicators, using the following WWF source: <https://riskfilter.org/biodiversity/inform/industry-overview>

4 Implications for actuaries

This section draws the content from previous sections together to illustrate the implications of biodiversity loss for actuarial work. It explores the transmission channels for nature related dependencies and impacts to affect assets, liabilities and the wider economic environment. Actuaries will need to consider the impact of these on their assumptions and valuations where, as for climate change, assumptions based on past data may not be a good predictor of future risks. Where relevant it considers the opportunities for economic actors to support global biodiversity and nature goals.

4.1 Economic Impacts

Biodiversity loss and nature related risks are recognised drivers of financial risks

Section 3 outlined how economic value creation depends on services provided by nature. Financial institutions are exposed to businesses highly dependent on nature through their lending, advisory, investing and underwriting activities meaning that losses to these companies due to ongoing nature decline can be transmitted to the financial sector. As a result, biodiversity loss and nature related risks are widely acknowledged by regulators¹², central banks^{9,10} and industry^{8,26}, to drive risks for the financial sector. At the same time, decisions made by financial institutions facilitate impacts on nature that can be positive or negative. This dependency and impact is known as [double materiality](#) and can give rise to transition risks to financial institutions. Sections [4.2](#) and [4.4.2](#) explore how nature can be impacted by underwriting and financing activities, including how risks and opportunities may arise.

Biodiversity loss and nature related risks give rise to systemic risks such as pandemic emergence, geopolitical instability and conflict

Systemic risks are those risks that impact a large number of actors in a system due to cascading impacts that spread between sectors. Biodiversity loss, including its interactions with climate change could generate systemic risks for the financial system and threaten financial stability⁶¹. The following aspects of biodiversity and nature loss contribute to the emergence of systemic risks:

- **Direct systemic impacts:** Many of the consequences of biodiversity and nature loss have direct systemic impacts. For example, biodiversity loss drives pandemic emergence^{17,61} (a systemic risk), whilst the disruption of globally important ecosystems, such as the Amazon rainforest would have system wide impacts⁶¹ because of the significance of the ecosystem itself. Interactions with climate change also increase the likelihood of large scale, system wide impacts, as healthy ecosystems provide resilience to climate shocks⁶¹.
- **Interactions between ecosystems:** Disruption of one ecosystem service can disrupt the delivery of other ecosystem services leading to widescale disruption on its own⁶¹.
- **Political instability and conflict:** Second order impacts are driven by both climate and nature related physical risks and include forced migration of communities who are highly dependent on nature, conflict resulting from shortages of natural resources and economic strains that result. Both can lead to political instability both within and beyond affected countries and communities. It is estimated that by 2050, land degradation and climate change are likely to force 50-700m people to migrate⁸³ and that a 5% decline in GDP has been associated with a 12% increase in violent conflict⁸³ in dryland areas which are particularly vulnerable to reduced land productivity.
- **Supply chain disruption:** Whilst biodiversity and nature loss are often localised, supply chain impacts can disrupt international trade in other related sectors.
- **Demand shocks:** Sectors with high impacts on biodiversity and nature may face reduced demand because of transition risks, again with impacts across the full value chain.

The level of uncertainty around systemic impacts is high, meaning they are unquantifiable and thus remain absent from quantitative scenario analysis. The systemic nature of these risks means that managing them involves addressing the primary issue of biodiversity and nature loss across the economy.

Direct economic impacts will be felt unequally across geographical locations and economic sectors however all economic actors may be affected through systemic risks and macroeconomic effects

Sectors that are highly dependent on biodiversity and ecosystem services face direct disruption to their operations due to ongoing nature decline. However, it is important to recognise that although a business may not intrinsically be reliant on nature to operate, it may be affected by virtue of its geographical location – for example a business whose headquarters is located along a stretch of coastline protected by coral reefs or mangroves will face higher operational risks from storm surge and flooding if those ecosystems are destroyed.

Sectors whose operations have large impacts on nature, face a general commercial environment that is increasingly aware (see sections [4.7](#) and [4.8](#)). Regulation and legislation to prevent nature loss is expected to increase as governments plan to meet their climate change and biodiversity commitments. These sectors will need to adapt their existing business practices or face disruption and risk stranded assets.

Macroeconomic variables such as GDP, Inflation and interest rates also need consideration. The WEF estimates that industries highly and moderately dependent on nature generate 15% and 37% global GDP respectively. Larger economies (China; \$2.7trn, EU; \$2.4trn, US; \$2.1trn) have the highest absolute amounts of exposure whilst some of the fastest growing economies have a high percentage of GDP generated from nature dependent sectors (India; 33%, Indonesia; 32%, African continent; 23%)⁸.

Changes in productivity of economic sectors may impact balance of payments positions through changes in imports and exports with associated consequences for currency exchange rates. This is particularly important for countries outside of the main reserve currencies who rely on exports to access global dollar markets. Volatility in domestic currency values has implications for these countries when rolling over private or public sector debt denominated in dollars. Disruption to supply chains from both physical and transition nature related risks can be expected to increase inflationary pressures, with the impact on interest rates dependent on the central bank response.

4.2 General insurance liabilities

In this section we start by exploring the ways in which general insurance claims may be impacted by biodiversity and nature related risks. This is followed up by considering the ways in which general insurance underwriting can affect nature both positively and negatively.

Physical risks can materialise across general insurance liabilities

Biodiversity loss could lead to a higher frequency or severity of claims and greater geographic or sectoral concentration of claims.²⁰ Natural structures such as forests, wetlands and coral reefs protect against extreme weather and natural hazards such as flooding and storm surge. There are interactions with climate change which increases the frequency and severity of extreme weather events, meaning that together climate change increases the risk from perils themselves and biodiversity loss increases vulnerability and reduces resilience to the impacts.

To identify how nature related risks could impact claims, insurers would need to explore potential transmission channels across their underwriting book. This involves assessing policyholder dependencies on nature (by virtue of the activity or geographical location as discussed in section 3.1) and exploring whether a loss of the identified ecosystem services would give rise to a claim under the policy terms. Exploring interconnections between risk drivers is a key part of this since nature related risks often interact with each other as well as climate related risks.

The transmission channel may be direct, for example crop insurance policies facing increased claims due to loss of soil fertility, formation, and pollination. However, the geographical element means that policies covering property damage or business continuity may be impacted following loss of natural structures at particular locations. Moreover, disruption to supply chains means that risks may materialise many miles from the original event affecting claims on non-damage business interruption policies.

Transition risks can materialise across general insurance liabilities

Transition risks can emerge as insurance liabilities because of litigation against companies with high impacts on biodiversity where director & officer's, general liability, professional indemnity, or errors & omissions insurance lines are written¹⁹.

Direct litigation may occur against insurers who underwrite activities that contribute to biodiversity and nature loss

This risk increases as society in general becomes more aware and raises expectations¹⁹. Insurers in line with other corporates are also exposed to action against them due to greenwashing and failure to transition their business models.

Some insurance may become unaffordable or uninsurable

As insurers begin to incorporate increases in risk into their pricing, geographical areas or activities that are highly dependent on ecosystem services may face higher prices or fall out of risk appetite altogether, increasing the [protection gap](#). This raises questions of fairness for communities. In the climate change arena, public sector backed schemes such as FloodRE in the UK and the National Flood Insurance Programme (NFIR)²⁹ and Fair Access to Insurance Requirements (FAIR) in the US have been required to ensure that insurance is obtainable and affordable²⁹. On the transition side, activities which have high impacts on nature may be deemed too risky to insure due to reputational risks.

Underwriting decisions facilitate impacts on biodiversity and nature

The presence of insurance and financing is a factor in allowing economic activity to occur. Insurance and financing also interact, with the presence of insurance over an activity making that activity less risky for investors. The insurance industry therefore has an impact when it underwrites insureds who are engaged in activities that damage biodiversity. This includes commercial lines business covering high impact sectors such as agriculture, construction & engineering, marine and aviation¹⁹. The UK based insurer, Aviva⁸⁵ has made a commitment to identify key areas of biodiversity dependencies and impacts across their underwriting, recognising the role it plays.

Systematically assessing nature impacts from underwriting activities is likely to involve, reviewing the current underwriting book to identify clients that have high impacts on nature by virtue of their business activities or geographical location using approaches discussed in section [3.2](#). These assessments could then be used to engage with clients with high impacts or set targets to reduce impacts from the underwriting book.

Insurance also has a role in providing cover for activities that halt and reverse biodiversity loss, which in turn can positively feedback on their liabilities. The World Bank²⁰ highlights 3 ways in which insurers can promote investment in biodiversity through their insurance activities:

- Asset protection where insurance is used to protect natural assets
- Liability reduction by offering protection for corporations that accidentally damage biodiversity and incorporating biodiversity considerations into their risk selection and pricing
- Offering catastrophe bonds or parametric covers that bring in capital investment

Insurers can contribute towards efforts to halt and reverse biodiversity loss through providing insurance coverage for Nature Based Solutions

Nature based solutions are actions that protect, sustainably manage and restore natural or modified ecosystems whilst addressing societal challenges, simultaneously providing benefits to human well-being and biodiversity⁶⁸. Examples of nature based solutions include sustainable forestry and reforestation, restoration of wetlands, mangroves and protecting coral reefs, halting peatland conversion and sustainable agriculture. See Box 2 for an overview of Nature based solutions.

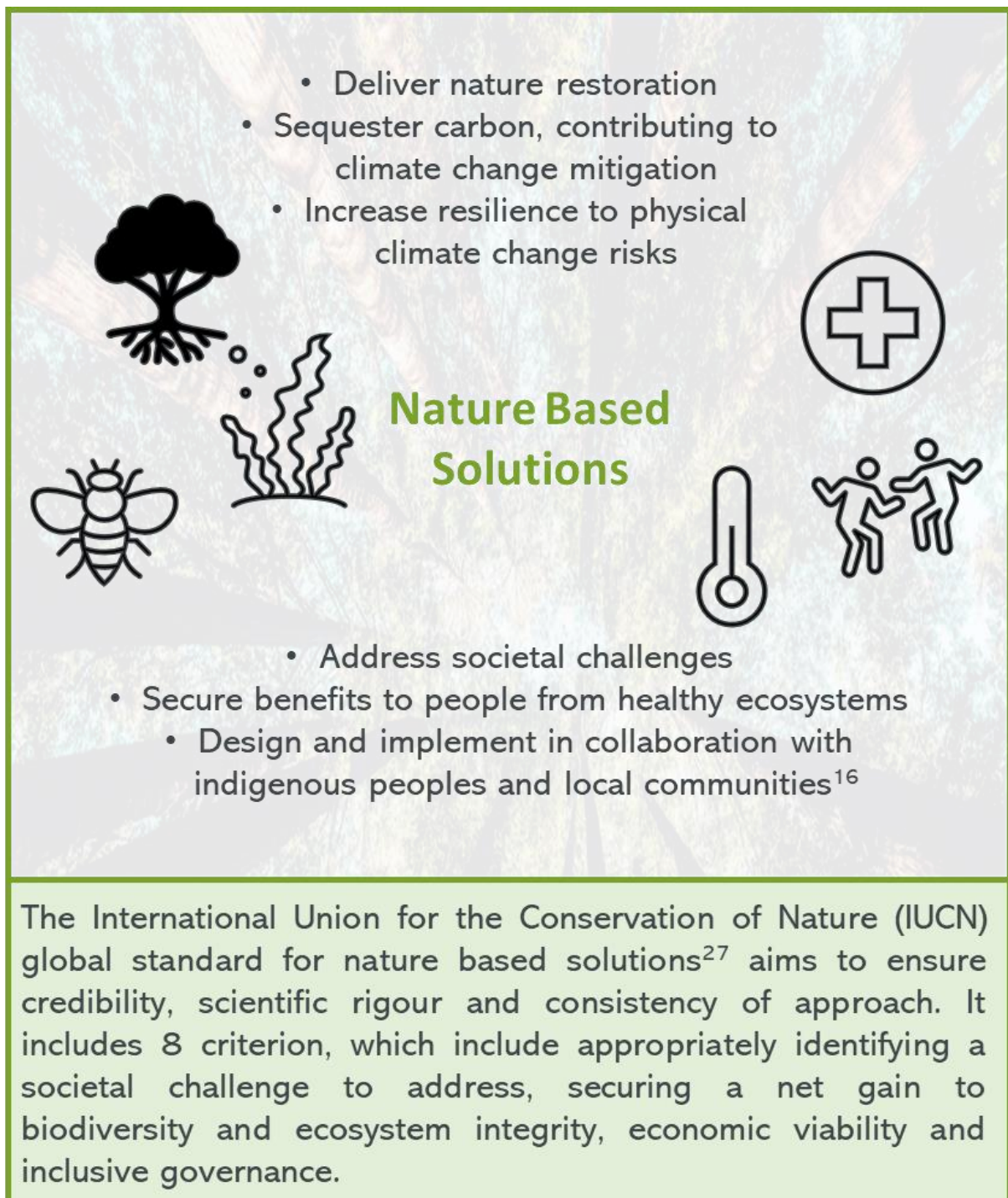
The Geneva Association¹⁹ gives several examples in this area, often involving partnerships between the private and public sectors or redesigning products:

- Premium reductions for ecological forestry (reflecting reduced fire risk) alongside parametric insurance that facilitates faster access to funds
- Parametric insurance for coral reefs to facilitate rapid repair after damage
- Insuring mangroves, seagrass, and saltmarshes
- Expanding builder's risk coverage to cover mass timber (a sustainable class of engineered building material)

Nature based solutions, which are designed to increase resilience to nature and climate related physical risks, can reduce impacts on insurance claims

The Geneva Association¹⁹ highlights the example of “The Nature Force” where a group of 15 insurers alongside a non-profit organisation have invested in nature based solutions in Canada in high flood risk areas, the insurers in turn collectively benefit from the reduction in flood risk to their businesses. This highlights both the benefits of nature based solutions as well as the need for industry collaboration and innovation to make them effective.

Box 2: Nature Based Solutions



Nature Based Solutions

- Deliver nature restoration
- Sequester carbon, contributing to climate change mitigation
- Increase resilience to physical climate change risks

- Address societal challenges
- Secure benefits to people from healthy ecosystems
- Design and implement in collaboration with indigenous peoples and local communities¹⁶

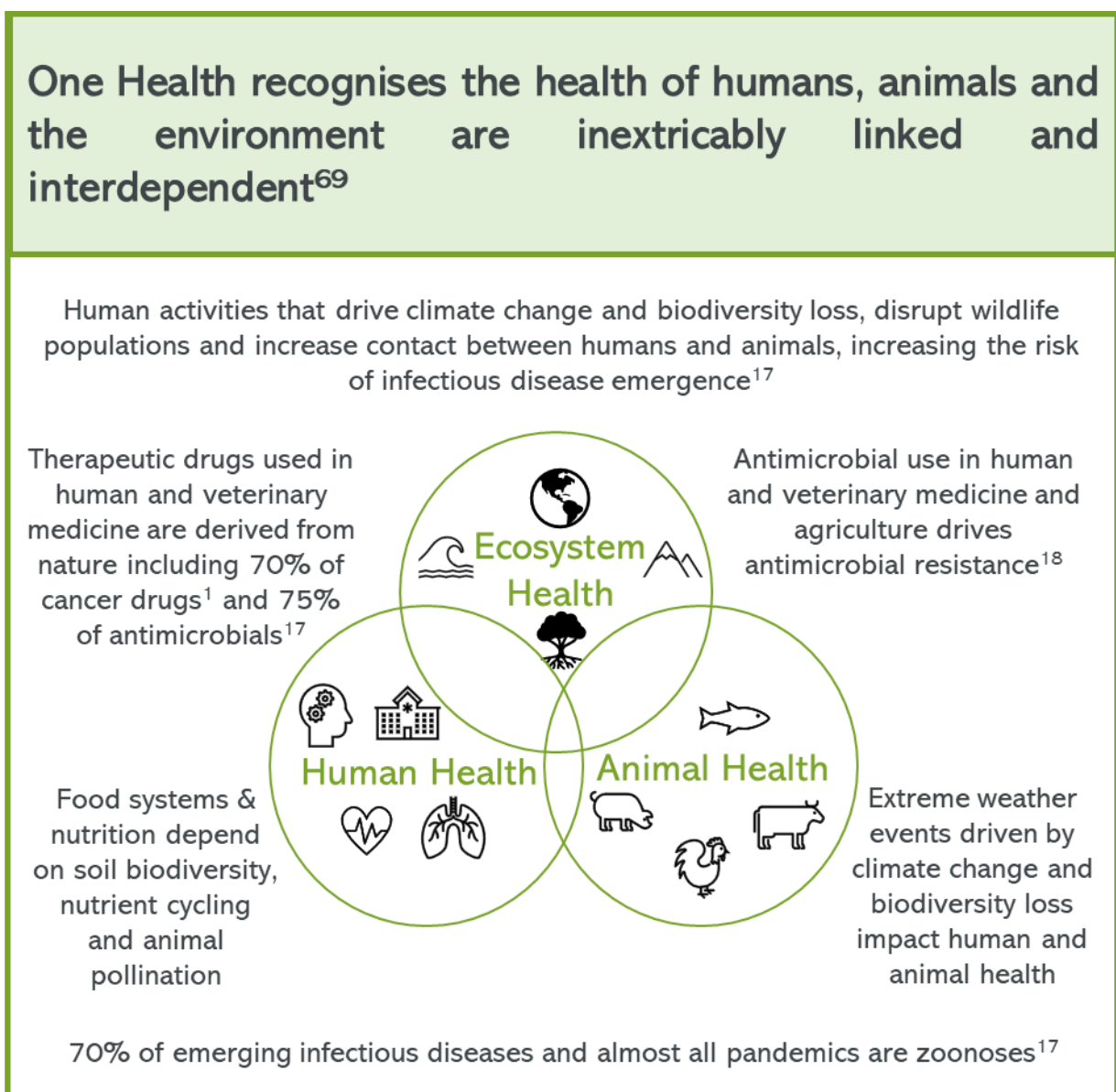
The International Union for the Conservation of Nature (IUCN) global standard for nature based solutions²⁷ aims to ensure credibility, scientific rigour and consistency of approach. It includes 8 criterion, which include appropriately identifying a societal challenge to address, securing a net gain to biodiversity and ecosystem integrity, economic viability and inclusive governance.

4.3 Life & Health liabilities

Human health is impacted by and dependent upon the natural environment meaning that nature related physical risks can materialise across life and health insurance liabilities

“One Health⁶⁹” recognises the complex interactions between human health and the rest of the biosphere by considering the relationships between human health, animal health and ecosystem health. Systemic risks to human health such as zoonotic disease, pandemics, food safety and antimicrobial resistance sit at the interface of these areas. It highlights the importance of double materiality, emphasising that human activities drive climate change and biodiversity loss which in turn feedback to impact human health. Box 3 summarises the “One Health” framework.

Box 3: Overview of One Health



Considering activities that drive changes in ecosystem, animal and human health and their interactions helps understand transmission channels for risks to emerge.

The following examples show how nature related risks may influence human mortality and morbidity, medical expenses and availability of healthcare leading to an impact on claims for life and health insurers:

Infectious disease: Climate change and biodiversity loss lead to changes in the geographical ranges of animal populations, including disease vectors such as mosquitoes and ticks¹⁷. Land use change, climate change and biodiversity loss create synergies that drive the emergence of infectious diseases and pandemics, the majority of which are zoonoses¹⁷.

Therapeutics: Many therapeutic drugs are derived from (or are synthetic products inspired by) nature. This includes 70% of cancer drugs¹ and 75% of approved antimicrobials¹⁷.

Antimicrobial resistance (AMR): Environmental pollution with antimicrobial agents (following use in human and veterinary medicine and agriculture), chemicals, pharmaceuticals and microplastics as well as biodiversity loss and climate change are linked to the emergence of AMR¹⁸. This in turn has consequences for our ability to treat human diseases, with almost 5 million deaths associated with AMR in 2019 and estimates indicate this could reach 10 million annually by 2050¹⁸.

Local climate & pollution: Natural structures such as trees regulate air quality, local climate and remove pollution whilst wetlands filter wastewater and eliminate pathogens.

Nutrition: Human nutrition depends on nature with 75% of global food crops relying on animal pollination¹ and soil quality, fertility and nutrient cycling is critical for food production.

Mental health: Nature plays a vital role in cultural and recreational activity, key to maintaining good mental health.

Extreme weather events: Climate change drives an increase in the frequency and intensity of extreme weather events whilst nature loss reduces our resilience to the impacts. Extreme heat events can cause infectious disease outbreaks, spoiling of foodstuffs, increase the incidence of cardiovascular and respiratory diseases⁶⁴ and reduce the availability of healthcare in directly affected regions.

Availability of healthcare: Timely access to appropriate healthcare is important in delivering good health outcomes. Systemic aspects of biodiversity risks such as pandemics, supply chain disruptions or interactions with climate shocks can affect the availability of healthcare. They can also increase costs associated with medical expenses, which may be due to supply chain impacts or due to an increased demand for healthcare.

Healthcare provision has impacts on nature

As discussed earlier, the healthcare sector uses disinfectants, antimicrobials and other pharmaceuticals, the waste products of which contribute to environmental pollution and antimicrobial resistance.¹⁸ A recent paper from the Finance for Biodiversity Foundation found that both Health Care Providers & Services and Pharmaceuticals were in the “Top 10” high-impact industries from a biodiversity perspective. See [Appendix B](#) for a comparison across studies. Since climate change is a key driver of biodiversity loss, it is important to note that the carbon footprint of the healthcare sector is 4.4% of global net emissions, making it the 5th largest emitter if it were a country⁶⁴. As we have discussed human health is negatively impacted by both climate change and biodiversity loss, highlighting again double materiality and meaning that the healthcare sector has an imperative to reduce its impacts.

4.4 Asset risks and opportunities

This section covers key implications of biodiversity and nature loss for investments. It contains material relevant to a range of actuarial stakeholders including asset owners, asset managers and risk managers. Again, the concept of double materiality applies and we start with “outside in” risks – highlighting the ways in which investments may be impacted by nature related risks, followed up with “inside out” risks – highlighting the ways in which investments affect nature.

4.4.1 Impact of nature related risks on investments

Physical risks may manifest as reduced returns from sectors with high dependencies on biodiversity

Physical risks may materialise directly for companies highly dependent on ecosystem services. As these services decline or more investment is required to alleviate losses, so could returns from these companies. Moreover, since disruption to one ecosystem service can disrupt other ecosystem services⁶¹ there may be cumulative effects. For example, activities such as agriculture may experience lower crop yields or brewers and vintners may experience operational disruption due to increased stress on water resources.

As explored in [section 3.1](#) geography plays a huge part, with any activities taking place in geographical areas that rely on natural structures (e.g. coral reefs, wetlands, forests) for physical protection, food and livelihoods vulnerable to nature related physical risks. Physical risks may lead to impairment of assets, collateral, and lower corporate profitability. This can feed through into changes to market risk, credit risk, refinancing/liquidity risk and operational risk^{9,20}.

Physical risks may reduce overall market return

Given the systemic aspect of nature related risks, externalities from high impact companies are borne across the whole market, damaging the profitability of other companies, and reducing market return. For large, diversified, and long term portfolios (such as life insurance assets and pension funds) it is impossible to sell out of externality producing firms; the costs of firm specific externalities are borne across the remainder of the holdings³¹.

For example, environmental contamination with antibiotic residues damages ecosystems and drives the emergence of antimicrobial resistance, this has negative impacts on the health of the labour force, a consequence felt across the whole market. Shortages of raw materials have impacts for the global economy contributing to higher prices and supply chain disruption.

Transition risks may manifest for companies with high impacts on biodiversity

As legal and regulatory positions evolve to reduce nature related impacts and internalise the costs of them onto the firms that cause them, return from these firms may be reduced. As nature related risks become more widely recognised, expectations from the public on responsible behaviour from firms may increase. Additionally, disruptor firms may leverage their sustainability practices as part of their brand. This can manifest as reduced demand for products from companies with high impacts on nature.

This can lead to stranded assets which arise when where environmentally unsustainable assets suffer from unanticipated or premature write-offs, downward revaluations or are converted to liabilities³³. [Section 3.2](#) highlights economic sectors with high impacts on nature, as ever this should be assessed alongside geography of operations and investment exposures when prioritising management actions, which could include engaging with companies to reduce their impacts and transition risks.

Litigation risks may manifest as reduced returns from companies facing litigation

Companies that have high impacts on biodiversity and nature loss could bear costs associated with litigation. This may reduce returns from investments in these companies. Direct litigation may also occur against investors who provide finance to activities that contribute to biodiversity and nature loss. Companies are also exposed to reputational damage from greenwashing, particularly as disclosure and governance requirements ramp up.

4.4.2 Impact of investments on nature

Targets 14, 15 and 19 (highlighted green in box 1) of the GBF⁷ directly reference finance, recognising the role it plays in halting and reversing biodiversity loss by 2030

Target 14 recognises the role of ensuring financial flows are aligned with biodiversity values, target 15 focuses on business and in particular financial institutions to monitor, assess and disclose their dependencies and impacts on biodiversity and target 19 aims to mobilise financial resources to deliver biodiversity strategies and action plans.

Financing facilitates economic activity meaning that investors have a role to play in directing capital towards sustainable outcomes to facilitate transition in the real economy

This is particularly important where new capital is raised in primary markets (e.g. issuing *new* bonds or shares) or money is created through bank lending because it impacts the costs faced by the issuing company. Bank lending is therefore a key area where finance should be directed towards activities that halt and reverse biodiversity loss and away from nature damaging activities. Despite this, in 2019, a report by Portfolio Earth found that the world's largest banks provided \$2.6 trillion for sectors that drive biodiversity loss³⁴. A report from the Institute of Innovation and Public Purpose (IIPP)¹¹ suggests ways in which regulators and central banks could use policy levers such as capital requirements, maximum exposure limits, collateral eligibility and asset purchase programmes to steer capital away from brown and towards green activities.

In the secondary market, divesting from a company stock or bonds has a less direct impact on company operations since the company has already obtained financing regardless of shares or bonds passing between investors. Investors can have a positive impact through engagement and stewardship activity with companies to improve their practices. Indirectly, high profile divestment campaigns may impact share price with consequences for management and potentially increasing cost of capital for future issues.

Providing finance to activities that halt and reverse biodiversity loss particularly in primary markets and private markets is an opportunity to contribute to global biodiversity goals and reduce impacts. The Geneva Association¹⁹ highlights an example of investing in sustainable agriculture and timber and the World Bank²⁰ highlights investing in green bonds whose proceeds are limited to biodiversity conservation. Blue bonds⁸⁹ are also available, with proceeds directed towards the protection and conservation of marine ecosystems, helping to achieve biodiversity and climate goals⁸⁶. The Seychelles was the first country to issue blue bonds in 2018, raising \$15m to transition towards sustainable fishing and extend the protected marine areas surrounding the country⁸⁶. Both private and public institutions have since followed suit.

Investment products can also be designed with nature goals in mind, for example Aviva Investors³⁴ offer a Natural Capital Transition Fund which invests in companies providing products & services that can accelerate the transition to meeting biodiversity goals, or companies that are leading their sector in reducing their impacts on nature.

Well-functioning, land and ocean ecosystems are carbon sinks. To date they have absorbed c.60% of global carbon emissions¹ meaning that investing in nature is critical to mitigating both the biodiversity and climate emergencies⁶⁵

Investors can facilitate efforts to halt and reverse biodiversity loss, meet climate targets and address social goals through investing in Nature Based Solutions, this in turn contributes to reducing the physical risks faced by investors. However, there is a funding gap, particularly from the private sector which makes up only 14% of the funding for nature based solutions (compared to 86% from the public sector)⁶⁶. In totality, investment in nature based solutions needs to triple in real terms by 2030 and increase fourfold by 2050 to meet climate and biodiversity targets⁶⁶. Investors including Axa IM³⁵ and Aviva³⁶ have announced investments in nature based solutions as part of climate and biodiversity strategies and the European Investment Bank's (EIB) Natural Capital Financing Facility (NCFF) aims to boost investment in conservation and nature based solutions³⁷.

4.5 Pensions

Sections [4.3](#) and [4.4](#) are relevant to pensions actuaries since nature related risks could impact both pension scheme liabilities and assets. Pensions actuaries will need to understand transmission channels of the risks and how these might impact the actuarial assumptions they recommend such as investment returns, inflation and mortality. As with climate change, assumptions based on past data (when ecosystems were more intact) may not be a good predictor of the future. A key consideration for defined benefit pensions schemes is how nature related risks may impact the strength of sponsor covenant. This will vary by scheme depending on business activities and geography of operations.

Pension scheme members may increasingly demand that their investments are not contributing to nature loss and seek information on trustees' policies and practices in this area. Actuaries have a role in bringing this subject to the attention of their clients.

4.6 Reporting and disclosure

Requirements for companies to identify, manage and disclose their nature related dependencies and impacts are increasing, including recognising the role of insurance underwriting activities and double materiality

The formal recognition of the role of finance in the GBF as well as organisations such as the International Sustainability Standards Board (ISSB) and the Taskforce for Nature related Financial Disclosures set expectations for financial services firms to identify, assess, measure and report on their nature related risks. Whilst organisations such as ShareAction engage with companies through shareholder activism and investor coalitions to drive change on key sustainability topics. This ramps up pressure on companies and regulators to respond which is discussed in section [4.8](#).

The ISSB is a standard setting board of the International Financial Reporting Standards (IFRS) foundation which aims to address the fragmented landscape of sustainability reporting and improve comparability

The ISSB aims to build on the work of market-led initiatives such as the Taskforce for Climate Related Financial Disclosures (TCFD) rather than redesign completely. They aim to deliver a global baseline of sustainability related disclosure standards which can provide investors with information about sustainability related risks and opportunities and in turn support informed decision making. IFRS Sustainability Disclosure Standards are expected to be published in 2023.

At COP 15 in Montreal, the ISSB announced its intention to advance work on natural ecosystems⁹⁰ and consider the work of the Taskforce for Nature Related Financial Disclosures (TNFD) and others where they relate to information needs of investors. They appointed 2 special advisors on natural ecosystems to support this work.

The TNFD is a global market led initiative which aims to deliver a risk management and disclosure framework for organisations to identify, assess, manage and report nature related risks

The rationale behind disclosing this information is to support financial flows away from activities that harm nature and towards those that halt and reverse nature loss²⁶. Beta versions of the framework are currently available, with a final version expected in September 2023.

The draft framework mirrors the TCFD's four pillars:

Governance: How an organisation's oversight and decision-making functions take nature-related risk and opportunities into account.

Strategy: The integration of actual and potential effects of nature-related risks and opportunities on the organisation's business model, strategy and financial planning.

Risk & impact management: How the organisation integrates nature-related risks into its overall risk management approach.

Metrics and targets: Quantitative and qualitative performance indicators and aims related to nature-related risk and opportunities, based on nature dependencies and impacts.

To support entities with their nature-related risk and opportunity assessments, the TNFD has developed voluntary guidance, known as the LEAP approach, outlined below:

- **Locate** your interface with nature
- **Evaluate** your dependencies and impacts
- **Assess** your risks and opportunities
- **Prepare** to respond to nature-related risks and opportunities and report.

An extended LEAP approach for financial institutions (LEAP-FI) has also been developed which addresses the complexities in relation to financial institutions. It was developed with the needs of banks, insurers, asset managers, asset owners and development finance institutions in mind.

A number of voluntary initiatives cover accounting for biodiversity and encourage companies to set targets to align their business models with biodiversity and nature goals. These include the Finance for Biodiversity pledge, Science Based Targets for nature and the Partnership for Biodiversity Accounting Financials (PBAF). An overview of these initiatives is provided in [Appendix C](#).

4.7 Reputational risks

Reputational risks can arise from several sources including direct physical impacts, litigation and disclosures

Companies with high impacts on nature and those who finance them face reputational risks, particularly where they lag the rest of the market or are out of step with globally agreed targets for net zero or halting biodiversity loss. Organisations such as Share Action and Portfolio Earth have published research highlighting the role of insurance underwriting²¹ and banking⁸⁷ in facilitating biodiversity loss and climate change, highlighting inadequate action by insurers and banks. High profile litigation against companies can increase the awareness of biodiversity impacts and the role underwriting and financing play. Together these increase the risk of reputational damage for companies, investors and insurers with negative impacts on biodiversity and nature.

Disclosure requirements are another area where firms could face reputational risks, for example companies whose quality of disclosures falls behind their peers or through greenwashing, where companies misrepresent their positive contributions to nature or climate goals. Initiatives such as the Science Based Targets initiative³⁸, Science Based Targets Network³⁹ and the IUCN Global Standard for Nature Based Solutions²⁷ help to ensure activities are grounded in science and address greenwashing concerns. Despite these, carbon offset schemes have been criticised for being misused, with companies continuing business as usual whilst promoting nature based solutions and failing to make meaningful contributions to climate and biodiversity goals^{40,41}. It is important to note again that since biodiversity is often unique to the geographical location and not easily replaced meaning that offset schemes should be approached with caution.

As businesses move to address their impacts on nature including through their supply chain impacts, they are starting to assess the sustainability policies, reporting and disclosures in place at firms they do business with as part of their due diligence process. Managing reputational risks relies on having adequate governance in place over both internal processes and with external counterparties.

Actuaries themselves face reputational risk if they do not appropriately consider or communicate the potential impacts of nature related risks in their actuarial work, where they are material risk drivers.

4.8 Regulatory initiatives

Recognising that nature related risks could generate systemic risks for the financial system and threaten financial stability,⁶¹ central banks and regulators have moved to address these risks, setting out their regulatory expectations or work programmes. This section summarises the key regulatory activities relevant to nature related risks.

The existing Solvency 2 prudential regime covers all material risks. Firms should therefore be looking to assess the transmission channels and materiality for nature related risks as they do with climate related risks

Like climate risks, nature related risks are drivers of traditional prudential risks, with nature risks feeding through to impacts on assets, collateral, corporate profit, insurance liabilities, reputation and operations leading to changes to market, credit, counterparty, liquidity, underwriting, operational, reputational, and strategic risks. For climate related risks, EIOPA⁴⁵ have highlighted the expectation that risks beyond the one year time horizon that cannot be fully captured in Solvency II capital requirements should be captured through governance, risk management and the ORSA.

The ORSA requires firms to identify, assess, monitor, manage and report the short and long term risks they face or may face and to determine the own funds necessary to ensure that the undertaking's overall solvency needs are met at all times.⁴⁴ Given the discussion here of the ways in which nature related risks may manifest for (re)insurers and the recognition of this by regulators, this requirement would apply.

EIOPA have signalled that they aim to establish supervisory expectations for nature-related risks and impacts. In a recent staff paper⁹⁴ they highlight the need for regulators to integrate nature related risks into supervisory frameworks, contribute to establishing methodologies to assess nature-related risks and prevent the rise of protection gaps and systemic risks. They note that scenario analysis and stress testing will play a part and highlight the need for knowledge and data sharing across disciplines.

The EU taxonomy is a classification system, establishing a list of environmentally sustainable economic activities⁴⁹, that aims to direct investment towards sustainable projects that contribute to meeting the EU's climate and energy targets for 2030 and the European Green Deal

The EU taxonomy guides companies, investors and policymakers to understand which activities are sustainable and help avoid greenwashing. The Taxonomy has 6 environmental objectives, towards which sustainable activities may contribute including biodiversity objectives:

- Climate change mitigation
- Climate change adaptation
- **The sustainable use and protection of water and marine resources**
- The transition to a circular economy
- Pollution prevention and control
- **The protection and restoration of biodiversity and ecosystems**

The Network for Greening the Financial System (NGFS) 2022-24 work programme includes the intention to step up work on nature related financial risks⁴⁷

The NGFS are a group of 121 central banks and supervisors who on a voluntary basis contribute to developing environmental and climate risk management in the financial sector and support the transition to a sustainable economy. They define and promote best practice and conduct/commission analysis on green finance⁵⁰. In April 2021, the NGFS launched a taskforce to mainstream the consideration of nature-related risks across their streams of work.

In March 2022, the NGFS published a statement⁵¹ acknowledging that failure to account for, mitigate, and adapt to nature related risks is a source of risk for individual financial institutions and financial stability and therefore falls within the mandate of central banks and supervisors. Their 2022-24 work programme prioritises stepping up work on nature related financial risks⁴⁷.

As a member of the NGFS, the Bank of England have recognised⁴⁶ the role of nature related risks in driving financial risks, pledging to conduct further work to understand the extent to which they are not captured within the existing regime.

The European Central Bank (ECB) has set out its supervisory expectations for the risk management of climate and environmental risk⁵² acknowledging that loss of biodiversity and ecosystem services, resource scarcity and other environmental factors drive financial risks

Elsewhere⁵³, they have acknowledged that nature related risks are part of their mandate, highlighting the need for further progress on nature related risks.

The regulatory expectations include:

- Understand the impact of these risks on the business environment and integrate them into strategy decisions and business objectives
- Explicitly include climate and environmental risks in risk appetite and risk management frameworks and to include them in the process of ensuring capital adequacy
- Report them internally to make informed decisions
- Allow for climate and environmental risks when assessing credit, operational, market and liquidity risks
- Evaluate appropriateness of stress testing with a view to include climate and environmental risks in baseline and adverse scenarios
- Publish meaningful information and key metrics on material climate and environmental risks

An increasing number of central banks & supervisors are taking steps to address nature related risks and the financial stability implications. Details of these activities by financial institution are given in [Appendix D](#).

5 Opportunities for the actuarial profession

This section outlines practical next steps for actuaries to further their understanding about biodiversity loss and nature related risks and help their employers, clients and society respond.

Collaborate	Biodiversity loss is an example of a wicked problem – defined as something that is difficult to solve because it is complex and interconnected. It is therefore essential that actuaries work with other disciplines such as scientists, researchers, health professionals, asset managers, underwriters, and lawyers. One Health is an example of a multidisciplinary collaborative approach bringing together healthcare professionals with social scientists to learn from each other’s perspectives. Collaboration is not always easy, due to a lack of a common language and understanding meaning clear communication is of the utmost importance.
Define	Clear definition and classification of nature related risks is required to ensure they are treated consistently within organisations, appropriately identified, and communicated. Mapping nature related risk drivers onto traditional risk taxonomies will be a key task for actuaries. Clear definitions are also important when setting targets, establishing key risk indicators, and integrating into risk frameworks.
Engage	Biodiversity loss is relevant to actuarial work and may influence stakeholder decision making. It should therefore be discussed proactively with colleagues, clients, and other stakeholders to help them understand how it is of relevance to them. Exploring ways in which the market is responding to nature related risks can help future proof advice and prioritise activity. Engage with investment counterparties and insurance customers to align their business activities with the global biodiversity goals.
Incorporate nature related risks into the business model	Identify which nature related areas are relevant to the actuarial context and develop best practices for assessing materiality of nature related risks. Integrate nature related risks into risk management systems – including risk registers, matrices and frameworks in order that they are managed alongside traditional risks. As with climate related risks, the pervasive manner of nature related risks and their double materiality requires them to be considered at a strategic level.
Interactions with climate	Explore the interactions between nature and climate related risks and how this might impact the management of these risks, the business strategy and the approach to adaptation. Explore the ways in which new climate technologies interact with nature including recognising trade-offs when making decisions.
Methodology	Contribute to the development of methodologies to measure biodiversity related impacts and dependencies, develop approaches to address data gaps and bespoke asset classes (such as infrastructure or private equity).
Product development	Feed into the development of insurance and investment products that halt and reverse biodiversity loss, address the climate-biodiversity nexus and contribute to climate change adaptation or nature based solutions.

Public policy	Engage with industry initiatives and contribute to policy and decision making. Discuss nature related risks with public policy and corporate-social responsibility teams and look to incorporate nature related risks into external business discussions and campaigns. Those working for governments & regulators should work to identify where nature related risks may drive systemic risks and financial instability.
Quantitative and qualitative techniques	Approaches to measuring nature related risks are still under development, however, as outlined in section 3 , most incorporate two aspects – state of the ecosystem involved and nature of the activity. Actuaries can use their skills to understand these developments including their limitations and consider how they may be deployed appropriately in practice. Advising on data requirements (and how to approach data gaps) and assessment tools will be important for using these metrics in decision making, as well as incorporating these risks into scenario analysis and stress testing.
Research	Stay up to date with the latest research, regulatory and supervisory developments and progress company discussions in line with this. Understand that action can be taken now but be prepared to respond to emerging best practice. The rapidly changing nature of the area should not be a barrier to starting.
Scenario Analysis	<p>Uncertainties surrounding nature related risks (including interactions with climate change) are high, meaning scenario analysis is expected to play a key role in exploration and management.</p> <p>Climate change scenario analysis is now a core expectation of regulators,^K with them now turning their attention to nature related scenarios with the NGFS recommending the development of biodiversity related scenario analysis and stress tests.^{51,61} They have noted that it will be important to assess biodiversity risks in their own right as well as developing integrated climate and biodiversity scenarios where the two risks interact⁶¹. Nature related scenario analysis is a component of the forthcoming TNFD framework with the aim to work towards an integrated approach to climate and nature scenarios.⁶²</p> <p>The Inevitable Policy Response (IPR) has released the first integrated climate & nature scenario for investors “Forecast Policy Scenario + Nature⁶³”. This is a high transition risk scenario which includes policies to protect biodiversity hotspots, restore degraded land and the creation of biodiversity credit markets as well as interactions with climate change policy.</p> <p>High uncertainty means that many outcomes cannot be quantitatively determined, meaning actuaries will need to apply qualitative approaches where appropriate. This may be through exploring scenario narratives, helping</p>

^K PRA (SS3/19; climate scenario analysis should inform strategic planning & risk identification), EIOPA (Opinion on sustainability within Solvency 2; climate scenario analysis should be used in the ORSA), ECB (Guide on climate-related and environmental risks; stress testing should include climate and environmental risks in baseline and adverse scenarios).

Scenario analysis is a key component of TCFD reporting recommendations. Reporting based on the TCFD recommendations is mandatory in the UK for larger pension schemes. FCA listing rules also mandate TCFD reporting on a comply or explain basis. This was first introduced in December 2020 for [premium listed companies](#) (applying for accounting periods on or after January 2021 i.e. first published in early 2022) but was expanded to [standard listings](#) in December 2021 (applying for accounting periods on or after January 2022 i.e. first published in early 2023).

stakeholders understand where extreme impacts may occur gaining deeper understanding of key drivers and exposures. Throughout, it is important to keep in mind the role of risk management – exploring the possible, not just the plausible and safeguarding against outcomes that we want to avoid.

Actuaries can sense check scenario narratives and outputs, challenging them for plausibility based on empirical or scientific evidence. This is important to bear in mind, particularly when sophisticated, quantitative models are in use – actuaries should challenge whether scenario outputs stack up against the scientific evidence and understand the limitations of the models in use.

Understand

Upskill your knowledge on nature related risks, attend seminars, training sessions as well as reading and research. The IFoA digital communities platform allows IFoA members to connect with others working in the sustainability field. This will help understand how nature related dependencies and impacts manifest across business value chains. Understand the timeline across which nature related risks are expected to emerge and compare this to the timeline you are advising on to assist prioritisation.

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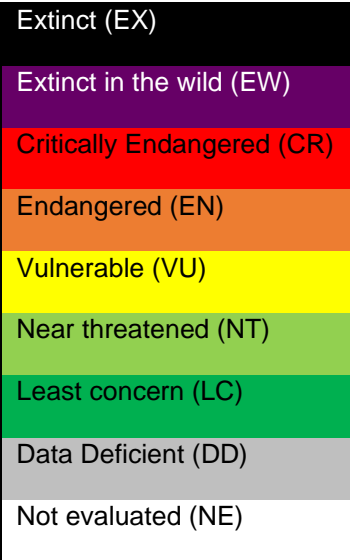
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Appendix A: Glossary

Biodiversity ²⁸	The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part. Biodiversity includes diversity within species, between species, and between ecosystems.
Biodiversity hot spot ²⁸	A generic term for an area high in such biodiversity attributes as species richness or endemism. It may also be used in assessments as a precise term applied to geographic areas defined according to two criteria: (i) containing at least 1,500 species of the world's 300,000 vascular plant species as endemics, and (ii) having lost 70 per cent of its primary vegetation.
Boreal Forest	The boreal forest, also known as “taiga,” are high latitude environments where freezing temperatures and snow cover occur 6-8 months per year. It spans 8 countries: Canada, China, Finland, Japan, Norway, Russia, Sweden and the United States and is the world’s largest land biome consisting of coniferous (e.g. pine, spruce, fir), broad leaf (e.g. poplar, birch) and deciduous trees as well as animal species such as caribou reindeer that are adapted to freezing temperatures. Approximately one third of the extent of the boreal forest is underlaid by permafrost. ^{91,92}
Double Materiality	The concept of double materiality recognises that <i>both</i> the impact <i>from</i> a company on climate change and biodiversity loss and the impact <i>to</i> a company from climate change and nature related risks are material. Double materiality recognises that the decisions we take today to address impacts influence the risks we face in the future.
Ecosystems	A community of living organisms (plants, animals, fungi and various microbes) in conjunction with the non-living components of their environment (such as energy, air, water and mineral soil), all interacting as a system ²⁸
Ecosystem Integrity Index	Ecosystem integrity ⁴² is a measure used to assess the current condition of an ecosystem. It incorporates consideration of the following: Ecosystem structure, which reflects habitat area, intactness, and fragmentation Ecosystem composition, refers to species present and overall species diversity Ecosystem functioning, evaluating the core processes that occur within the ecosystem
Ecosystem Services	The benefits people obtain from nature and ecosystems
International Union for Conservation of Nature (IUCN) Protected areas	A protected area is a clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values ²⁸ . The IUCN and the UN Environment world conservation monitoring centre maintain a global database of protected areas.

<p>IUCN Red List of Threatened species</p>	<p>The IUCN Red list is a comprehensive inventory of global extinction risk status of animal, fungus and plant species⁵⁸. For each species, The IUCN Red List provides information about its range, population size, habitat and ecology, use and/or trade, threats and conservation actions. There are 9 red list categories which indicate how close a species is to becoming extinct:</p> 
<p>Key biodiversity areas</p>	<p>Key Biodiversity Areas (KBA) are sites contributing significantly to the global persistence of biodiversity. The Global Standard⁴⁸ for the Identification of Key Biodiversity Areas defines the globally agreed criteria for identifying KBAs.</p>
<p>Natural Capital⁷²</p>	<p>The stock of renewable and non-renewable natural resources that combine to yield a flow of benefits to people⁷². Natural capital assets are elements within nature that provide the goods and services that the economy depends on⁷³.</p> <p>Exploring Natural Capital, Opportunities, Risks & Exposure (ENCORE) is an online tool that helps users explore business dependencies and impacts on nature and therefore identify transmission channels for risks to emerge. The ENCORE tool groups natural capital assets into the following: Atmosphere, Habitats, Land geomorphology, Minerals, Ocean geomorphology, Soils & sediments, Species and Water⁷³.</p>
<p>Nature positive</p>	<p>Many initiatives and organisation use the term “nature positive” with little consensus on the definition. However most tend to refer to reversing biodiversity loss and moving towards positive gains in biodiversity. Following COP 15 we have a new overarching global biodiversity goal to “halt and reverse biodiversity loss by 2030” which is specific and should replace terms like “nature positive” going forward, however the term remains in older publications.</p>

<p>Nature related risks</p> <p>(Definitions taken from the Task force on nature related financial disclosures (TNFD)³²)</p>	<p>Nature-related physical risks are a direct result of an organisation’s dependence on nature. Physical risks arise when natural systems are compromised, due to the impact of climatic events (e.g. extremes of weather such as a drought), geologic events (e.g. seismic events such as an earthquake), or events or changes in ecosystem equilibria such as soil quality or marine ecology which affect the ecosystem services organisations depend on. These can be acute, chronic, or both. Nature-related physical risks arise because of changes in the biotic (living) and abiotic (non-living) conditions that support healthy, functioning ecosystems. Physical risks are usually location specific. Nature-related physical risks are often associated with climate-related physical risks. Human activities drive the emergence of physical risks, for example forest and wetland clearance for commercial purposes increases the physical risks to an area from sea level rise and flooding. Another example is the disruption to natural habitats and ecosystems that occurs due to human activities like deforestation, livestock production and building settlements which drives the emergence of zoonotic diseases, pandemics and antimicrobial resistance.</p> <p>Nature-related transition risks are risks that result from a misalignment between an organisation’s or investor’s strategy and management and the changing regulatory, policy or societal landscape in which it operates. Developments aimed at halting or reversing damage to nature, such as government measures, technological breakthroughs, market changes, litigation and changing consumer preferences can all create or change transition risks.</p> <p>Liability risks are considered a subset of transition risks in the TNFD framework but sometimes specified separately elsewhere. This refers to risks that arise from litigation being taken against companies that adversely impact nature. For insurers, these risks can manifest as liabilities on policies such as Director & Officers cover, general liability, professional indemnity and Errors and Omissions (E&O) insurance. They could also arise from direct litigation against those providing financing or underwriting services to companies that adversely impact nature.</p>
<p>Protection Gap</p>	<p>The difference between total economic losses and insured losses</p>
<p>Tipping points</p>	<p>Within any complex system, there are multiple possible stable states, tipping points represent thresholds that when crossed move the system into one of the other alternative states. The change in the system is often much larger than the original stimulus that caused the shift with tipping points therefore being described as abrupt or non-linear. Tipping points have been identified in both the climate system and nature.</p>
<p>World Heritage Sites</p>	<p>A World Heritage Site is a landmark or area which is selected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as having cultural, historical, scientific or other form of significance, and is legally protected by international treaties. The sites are judged important to the collective interests of humanity.²⁸</p>

Appendix B: Identifying dependencies and impacts on nature

The high dependency and impact sector lists vary depending on the source of information, although there is overlap and common themes. This is due to different methodologies used in the analysis and groupings used for economic sectors. The UNEP-FI & Finance for Biodiversity analyses use Global Industry Classification Standards (GICS) groupings for sectors whereas the WWF BRF assesses 25 industry sectors using a modified version of the GICS groupings.¹⁴ A modified GICS list is used since some industries within a single GICS code face diverse biodiversity risks and so are better disaggregated, whilst others facing similar biodiversity risks can be grouped in the same category¹⁴.

For full details of the activities included in each sector classification please refer to the WWF BRF methodology¹⁴, UNEP FI Beyond Business and usual report⁸¹ and GICS methodology⁸² documents.

It should also be noted that the WWF & Finance for Biodiversity lists are in order of high to low dependencies/impacts, whereas the UNEP-FI list does not provide this distinction. Another point to note is that the Finance for Biodiversity analysis is based on the aggregated output from 4 biodiversity footprint tools, but the analysis covers only companies in the MSCI World Index meaning that the agricultural sector is underrepresented.⁸⁸

Appendix C: Voluntary initiatives; Measurement and Target setting

Finance for Biodiversity pledge⁵⁵

The Finance for Biodiversity Pledge was launched in September 2020 by 26 financial institutions, the current number of signatories stands at 126, across 21 countries and representing €18.8 trillion assets under management. The pledge aims to protect and restore biodiversity through financing and investment activities.

Signatories make the 5 following commitments by 2024 at the latest:

- **Collaboration and knowledge** sharing on assessment methodologies, biodiversity metrics, targets and financing approaches for positive impact.
- **Engaging** with companies to reduce negative and increase positive impacts on biodiversity
- **Assess the impact** of financing activities and investments for significant positive and negative biodiversity impacts and identify drivers of biodiversity loss
- **Set and disclose targets** based on best available science to increase positive and reduce negative impacts on biodiversity
- **Report publicly** on the above annually before 2025. Be transparent about the positive and negative contribution to global biodiversity goals linked to financing and investing portfolios

Science Based Targets Network (SBTN)

The science based targets network builds on the work of the Science Based Targets initiative (SBTi) which supports companies to set carbon emission reduction targets. For the SBTi targets are “science based” if they are in line with the actions climate science deems necessary to meet the goals of the Paris Agreement – to limit warming to 1.5°C. Setting a science based target involves 5 steps⁵⁶:

1. **Commit:** submit a letter to the SBTi establishing your intent to set a science-based target
2. **Develop:** work on an emissions reduction target in line with the SBTi’s criteria
3. **Submit:** present your target to the SBTi for official validation
4. **Communicate:** announce your target and inform your stakeholders
5. **Disclose:** report company-wide emissions and track target progress annually

The SBTN⁵⁶ expands this work to cover impacts and dependencies on all of earth’s systems, including water, land, ocean and biodiversity, with the broader definition of a science based target (SBT) being “*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*”.

The first SBTs are expected to be released in 2023 focused on water use and water pollution and land with subsequent releases increasing the issues covered. Until then, it is not possible to set science based targets for nature, but interim targets⁵⁷ have been identified that companies can set. These interim targets cover 5 types of action: Avoid, Reduce, Regenerate, Restore and Transform. They include zero deforestation and conversion from 2020, increasing ecosystem area under restoration and reducing water withdrawals in high water impact parts of the value chain. As for climate targets, there will be a validation process for nature targets. Many of the institutions mentioned here cooperate with one another including TNFD, SBTN, PBAF and Finance for Biodiversity Pledge and Align.

Partnership for Biodiversity Accounting Financials (PBAF)⁵⁴

PBAF is an independent organisation based in the Netherlands and supported by the Dutch government. It aims to develop a “PBAF Standard” which defines biodiversity impact and dependency assessment best practice. It currently focuses on impacts but aims to move to dependencies over time.

The latest version is PBAF Standard v2022 which consists of 3 documents:

- **Q&A - Introduction to biodiversity impact assessment**

Provides an introduction for financial institutions and impact investors new to biodiversity impact assessment.

- **Biodiversity impact assessment – Overview of approaches**

Outlines the approaches financial institutions can use to assess biodiversity impacts.

- **Biodiversity impact assessment – Footprinting**

Provides guidance, requirements and recommendations for biodiversity footprinting. Aimed at those with some experience of impact assessment as well as data and tool providers.

Align Project⁶⁷ – Aligning accounting approaches for nature

In March 2021 WCMC Europe, the Capitals Coalition, Arcadis, ICF and UNEP-WCMC launched the Align project, funded by the European commission. The 3 year business led project aims to develop a standardized approach to biodiversity measurement and valuation. It aims to develop methods, indicators and tools to support business and financial institutions to measure biodiversity impacts and dependencies, shifting from guidance to standardisation.

Appendix D: Central bank and supervisory activity

The table below summarises the ongoing central banks & supervisory activity with links to relevant publications⁶¹

Entity	Activity
Banco de Mexico	Initial research, assessment & policy signals <ul style="list-style-type: none"> Climate and environmental risks and opportunities in Mexico's financial system from diagnosis to action Conference on Biodiversity and Environmental Challenges for the Financial System Contributing to financial architecture <ul style="list-style-type: none"> Part of the TNFD forum
Banca d'Italia	Central bank non-monetary policy portfolios <ul style="list-style-type: none"> Responsible investment charter
Banco Central de Chile	Contributing to financial architecture <ul style="list-style-type: none"> Central Bank of Chile joins Natural Capital Committee
Banco Central do Brasil	Initial research, assessment & policy signals <ul style="list-style-type: none"> New regulation on risk management and social, environmental and climate responsibility Nature-Related Financial Risks in Brazil World Bank Group Working Paper 9759
Bank Negara Malaysia	Contributing to financial architecture <ul style="list-style-type: none"> Value-based intermediation financing and investment impact assessment framework guidance Climate change and Principle based Taxonomy
Bank of Albania	Initial research, assessment & policy signals <ul style="list-style-type: none"> Medium Term Development Strategy of the Bank of Albania 2021-2023
Bank of England	Initial research, assessment & policy signals <ul style="list-style-type: none"> Remit and recommendations for the Financial Policy Committee – March 2021 (bankofengland.co.uk) Remit for the Monetary Policy Committee - March 2021 (bankofengland.co.uk) Contributing to financial architecture <ul style="list-style-type: none"> Part of the TNFD forum
Bank of Mauritius	Contributing to financial architecture <ul style="list-style-type: none"> Guide for the issue of sustainable bonds in Mauritius
Banque de France	Initial research, assessment & policy signals <ul style="list-style-type: none"> A "silent spring" for the financial system? Exploring biodiversity-related financial risks in France. Contributing to financial architecture <ul style="list-style-type: none"> Part of the TNFD forum Financial Market conduct <ul style="list-style-type: none"> Third Joint ACPR/AMF report Monitoring and assessing the climate commitments made by French financial institutions Central bank non-monetary policy portfolios <ul style="list-style-type: none"> Responsible Investment Report 2022
Central Bank of Nigeria	Contributing to financial architecture <ul style="list-style-type: none"> Implementation Sustainable Banking Principles

De Nederlandsche Bank	<p>Initial research, assessment & policy signals</p> <ul style="list-style-type: none"> • Indebted to nature. Exploring biodiversity risks for the Dutch financial sector <p>Contributing to financial architecture</p> <ul style="list-style-type: none"> • DNB's sustainable finance platform Biodiversity working group
EIOPA	<p>Initial research, assessment and policy signals</p> <ul style="list-style-type: none"> • EIOPA Staff paper on nature-related risks and impacts for insurance
European Central Bank	<p>Contributing to financial architecture</p> <ul style="list-style-type: none"> • The 3 European Supervisory authorities (European Banking Authority, European Insurance and Occupational Pensions Authority & European Securities and Markets Authority) are members of the EU platform on Sustainable Finance, advising the EU on the EU Taxonomy. • Part of the TNFD forum <p>Prudential policies & instruments</p> <ul style="list-style-type: none"> • EBA Report on Management and Supervision of ESG Risks for credit institutions and investment firms • Guide on climate-related and environmental risks
Financial Services agency of Japan	<p>Contributing to financial architecture</p> <ul style="list-style-type: none"> • Part of the TNFD forum
Magyar Nemzeti Bank	<p>Initial research, assessment & policy signals</p> <ul style="list-style-type: none"> • Parliament gives MNB sustainability mandate
Monetary Authority of Singapore	<p>Prudential policies & instruments</p> <ul style="list-style-type: none"> • Guidelines on Environmental Risk Management for Banks
Mongolbank	<p>Contributing to financial architecture</p> <ul style="list-style-type: none"> • Mongolian Green Taxonomy
Nepal Rasta Bank	<p>Financial Market conduct</p> <ul style="list-style-type: none"> • Guideline on Environmental & Social Risk Management for banks and financial institutions
People's Bank of China	<p>Contributing to financial architecture</p> <ul style="list-style-type: none"> • PBC Green Bond endorsed projects catalogue 2021 edition <p>Financial Market conduct</p> <ul style="list-style-type: none"> • Initial analysis of the financial flows and payment mechanisms behind wildlife and forest
Reserve Bank of New Zealand	<p>Initial research, assessment & policy signals</p> <ul style="list-style-type: none"> • Report acknowledging the implications of nature for the Te Ohanga Maori
Superintendenta de Banca, Seguros y Administradoras Privadas de Fondos de Pensiones	<p>Initial research, assessment & policy signals</p> <ul style="list-style-type: none"> • Resolution S.B.S No 1928-2015 requires firms to identify training and dissemination needs to adequately manage social and environmental risk <p>Financial Market conduct</p>
Swiss National Bank	<p>Central bank non-monetary policy portfolios</p> <ul style="list-style-type: none"> • Exclusion of assets from companies that "seriously damage biodiversity" from corporate bonds that are part of foreign currency reserves



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