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European Biodiversity Partnership

Strategic Research & Innovation Agenda

Horizon Europe Partnership on Biodiversity

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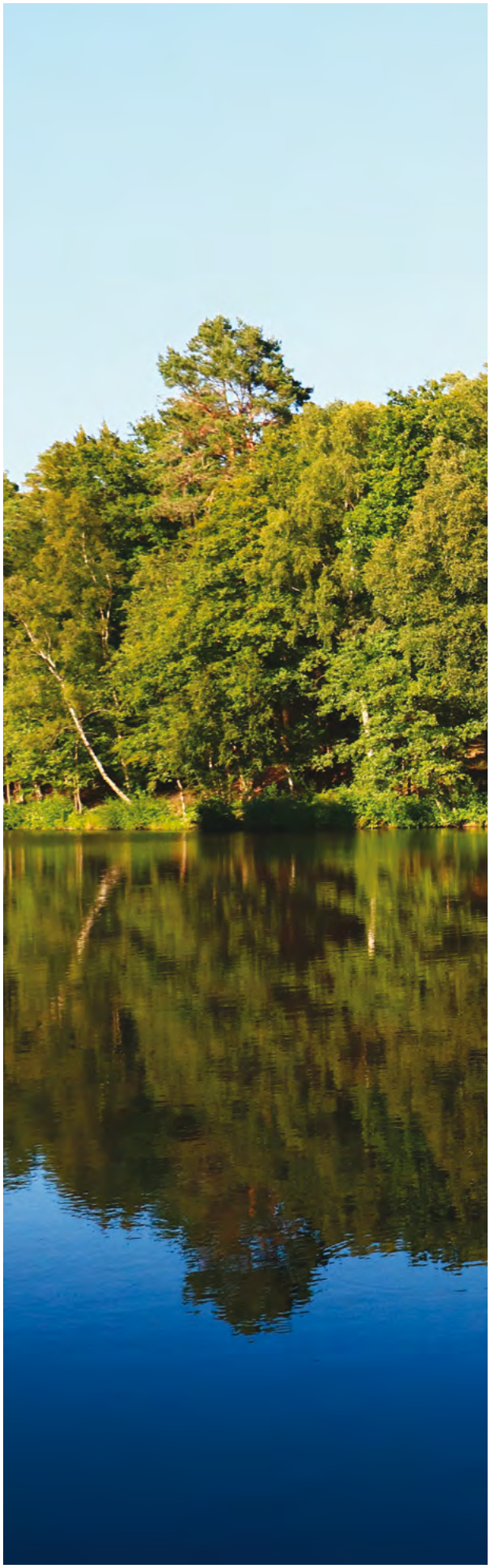

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LIST OF ABBREVIATIONS

CBD: Convention on Biological Diversity

FAIR: Findability, accessibility, interoperability and reusability

GBO: Global Biodiversity Outlook

IAS: Invasive Alien Species

IPBES: Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services

IPCC: Intergovernmental Panel on Climate Change

KBA: Key Biodiversity Area

MPA: Marine Protected Areas

NBS: Nature-based Solutions

NCP: Nature's Contributions to People

OCTs: Overseas Countries and Territories

ODA: Official Development Assistance

OECM: Other Effective Area-Based Conservation Measures

ORs: Outermost Regions

PA: Protected Areas

PES: Payment of Ecosystem Services

REDD: Reduced Emission from Deforestation and environmental Degradation

R&I: Research and Innovation

UNFCCC: United Nations Framework Convention on Climate Change

SEEA: UN System of Environmental Economic Accounting

SDG: Sustainable Development Goals

SRIA: Strategic Research and Innovation Agenda

FOREWORD

The narrow economic growth paradigm has come at a high cost for nature, as multiple anthropic drivers and pressures negatively impact biodiversity and ecosystem services. Worldwide, nature is declining at rates unprecedented in human history – and the rate of species extinction is accelerating with grave impacts for ecosystems, climate, health, economy and society. The recent outbreak of the covid-19 pandemics, for example, is a stark reminder of the possible implications of disrupted relation between humans and nature. **Rescuing biodiversity to safeguard life on earth** has now become one of the greatest challenges of our time. It is fundamental to achieving a more prosperous, just and equitable world. It will ensure that biodiversity will keep providing the necessary basis for human well-being and equity, economic growth and jobs.

Recent environmental assessments reveal that **urgent transformative change** can still turn these trends around. This transformative change will need to include all actors of society, including governments, citizens and businesses depending and impacting on biodiversity and nature's contributions to people. In complement to approaches already applied, **new and more systemic paths must be explored and promoted acknowledging interdependencies and reinforcing the synergies between biodiversity, human societies and economies**. Europe has to meet this challenge, fully recognizing that biodiversity is both a natural heritage to be conserved for future generations and a fundamental asset that provides the basis for transitioning towards a sustainable social and economic system, both in Europe and globally. In this context, the priority for research is not only to quantify and understand the status and trends of biodiversity and ecosystem service delivery and act as a warning device, which is crucial, but also to propose and promote solutions for overcoming these and strengthen action on the ground.

Keeping in mind the interests of the current and future generations, biodiversity is a natural heritage and public good to conserve as a moral duty. It is also a fundamental asset for Nature-based Solutions tackling numerous societal challenges. Nature-based Solutions can support European efforts by offering a holistic approach to address major challenges such as climate and water regulation, food quality and security, and sustainable urbanization, while at the same time providing business and job opportunities and promoting the protection, restoration and sustainable management of ecosystems. **By recognizing biodiversity as source for a sustainable economy and for sustainable development, Nature-based Solutions can help transform environmental and societal challenges into innovation opportunities** and can support the simultaneous achievement of environmental, societal and economic policy objectives. However, this cannot be taken for granted and more research is needed to investigate the relationship between biodiversity and Nature-based Solutions, and explore methods for assessing, developing and deploying Nature-based Solutions at scale. A greater understanding of how to effectively assess potential benefits of the implemented solutions and evaluate their possible drawbacks is also needed.

Moreover, the environmental and socioeconomic interactions between distant regions of the world are dramatically increasing. **Telecoupling brings about new challenges and opportunities to biodiversity conservation that are of a larger magnitude and faster pace than ever observed before**. Challenges are mostly due to the high demands for agricultural and wildlife products by high-income and emerging economies –including from Europe, putting pressure on land protection, management and incentive-based conservation interventions. Our understanding of the dynamics and leverage points of this telecoupled world is, however, limited. Better knowledge and evidence-based support to policy could here move the EU, individual governments and multinationals to adopt more sustainable practices.

The current polycrisis calls for **holistic approaches**, with greater focus on resilience, safeguards and buffers. The challenge for biodiversity research programs and funders is therefore to promote 'research supporting solutions' at scale, in complement to 'research raising the alarm'. This requires deep changes in the way we perform research on biodiversity issues, with stronger collaborations between scientific disciplines (including between natural sciences and social sciences and humanities), reinforced relationships between scientists and research stakeholders, deeper connection with the private sector, and enhanced international collaborations. Civil society participation (e.g. through citizen science) and co-production of knowledge with stakeholders should be brought more centrally into the frame. Profound changes in the way research programs and funders design, implement and evaluate their research programs, and increased support for cross-sectoral and cross-border research are also vital. Last but not least, reinforcing the link between research and policy can help to understand issues at stake, generate and evaluate policy options and monitor results of policy implementation.

Despite trends being overwhelmingly negative for biodiversity on Earth and the benefits that nature provides to people, there is still room for some optimism. In May 2020, the European Commission – as part of the European Green Deal - released the **EU Biodiversity Strategy to 2030 – Bringing nature back into our lives**[1]**. Along with the EU Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system**[2], it is a potential game changer as it proposes a new wave of ambitious targets on topics such as protected areas, restoration of nature, organic farming, and global action. The EU Biodiversity Strategy 2030 is also a crucial step in the pivotal year of 2021 during which the global targets for conserving life in the oceans and on land will be reset in the context of the Convention on Biological Diversity. Another milestone in 2021 is the 26th Conference of the Parties of the United Nations Framework Convention on Climate Change, an opportunity to reinforce the commitments under the Paris Climate Agreement and reinforce the highly needed, broader dialogue on the role of Nature-based Solutions to fight the twin crisis of nature loss and climate change.

Against this backdrop, the European co-funded Partnership on Biodiversity Biodiversa+ (hereafter referred to as the '**European Biodiversity Partnership**') will coordinate research programs between EU and its Member States and Associated Countries and trigger combined actions. Building on the advances allowed by BiodivERsA, it will mobilise for the first time in a systematic manner environmental authorities and environmental protection agencies in addition to ministries of research, funding agencies and foundations as key members of the Partnership for implementing biodiversity research and innovation and interfacing science-society/policy. The European Biodiversity Partnership is thus a public-public initiative, building on the efficient structuring of the European Research Area in the domain achieved by BiodivERsA that has demonstrated the openness, long-term financial commitment, innovation capacity and flexibility needed to have the required impacts since 2005. Over a timespan of 2021-2028, the European Biodiversity Partnership will implement an ambitious program contributing to the objective that "by 2030, nature in Europe is back on a path of recovery", and "by 2050 people are living in harmony with Nature". More particularly, the Partnership will put Research & Innovation at the heart of the implementation of the EU Biodiversity Strategy 2030 seeking to reverse biodiversity loss, by increasing knowledge on biodiversity dynamics, reinforcing biodiversity monitoring across Europe, developing Nature-based Solutions and providing science support to policy. It will generate both major scientific breakthroughts and societal/policy impacts to help making transformative change a reality.

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1. European Commission (2020) EU Biodiversity Strategy for 2030 – Bringing nature back into our lives (https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF)

2. European Commission (2020) EU Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system (https://eur-lex.europa.eu/resource.html?uri=cellar:ea0f9f73-9ab2-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF)

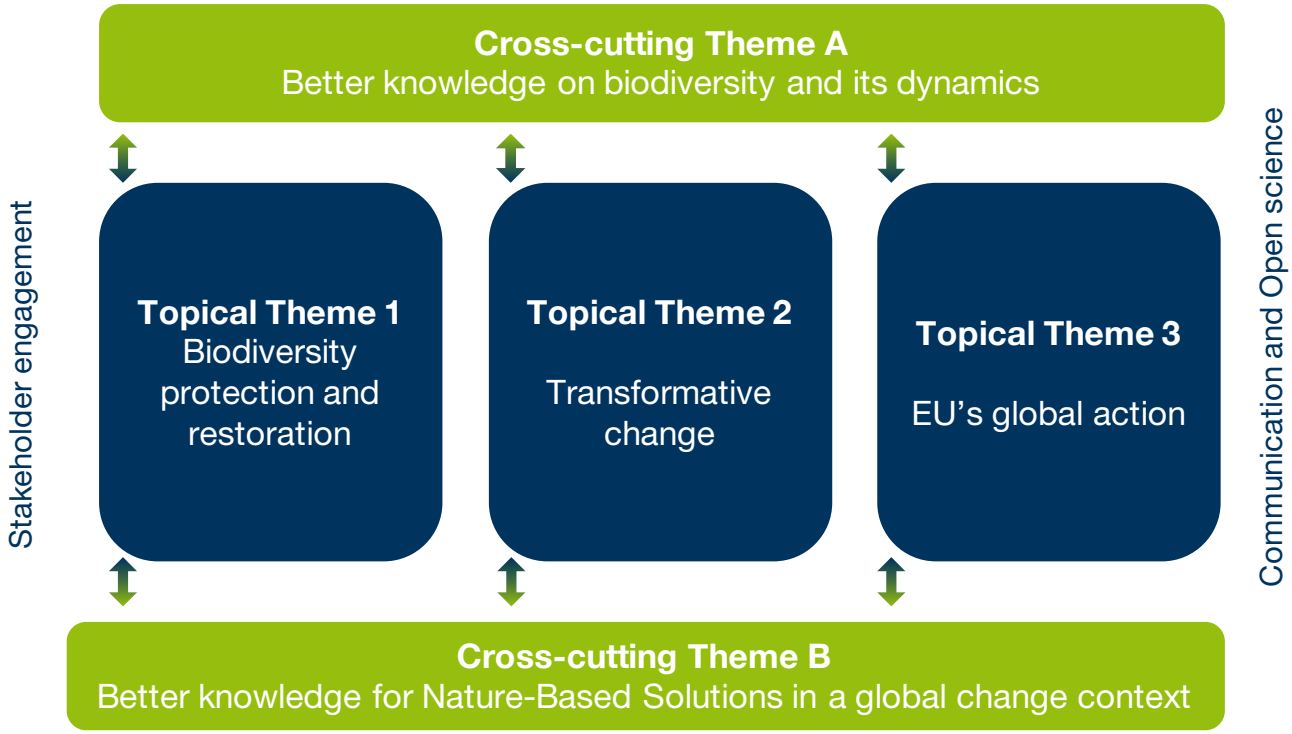
Noticeably, the European Biodiversity Partnership will set up **a pan-European network of harmonized monitoring schemes** able to measure and analyse biodiversity changes across Europe. It will also generate **new knowledge and tools to tackle the drivers of biodiversity loss, and to support decision-making and international policies and initiatives** such as the EU Biodiversity Strategy to 2030, the green pillar of the Common Agricultural Policy, the new targets defined under the post-2020 Global Biodiversity Framework of the Conference on Biological Diversity, the United Nations (UN) Sustainable Development Goals, the Paris Climate Agreement, and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). In addition, it will promote research and innovation related to biodiversity and Nature-based Solutions to support state-of-the-art approaches to conserving, restoring and sustainably managing biodiversity (i.e. both the European natural heritage and natural capital it represents) and promoting innovation and the European leadership for the development and deployment of Nature-based Solutions.

This **Strategic Research and Innovation Agenda (SRIA)** presents the **long-term strategic vision of the European Biodiversity Partnership**, including broad research themes that will guide a broad range of activities over the coming years. It covers all environments (freshwater, marine and terrestrial) and habitats, with specific focus on European added-value. With this SRIA, the partners of the European Biodiversity Partnership and the European Commission share a vision of Europe becoming a global leader in conserving, restoring and managing biodiversity, and developing Nature-based Solutions that contribute to its economy, supported by solid science-based knowledge. The SRIA will typically be updated every 3-4 years. Aligned with this SRIA, multi-annual Flagship Programmes will be launched (1-2 per year) tackling thematic issues through a wide array of activities. These include joint calls and alignment of national programs; activities related to biodiversity monitoring across borders; mobility schemes and young scientist schemes; activities to cover the research and innovation interface;

knowledge brokerage and transfer of research results to reinforce the impact of the funded projects; policy support; activities to evaluate achievements; support to open science; raising awareness on the importance and outcomes of biodiversity research; etc.). Details of the activities to be implemented by the European Biodiversity Partnership will be spelled out in annual implementation plans (i.e. plans specifying the multi-annual programmes launched each year).

The SRIA has been fed by a range of **mapping and foresight activities** conducted by BiodivERsA and associated COFUND actions. This was further supplemented by an in-depth literature study by the Coordination Team of BiodivERsA/European Biodiversity Partnership conducted in 2020. The work also benefited from advice obtained from the BiodivERsA Advisory Board (composed of top scientists and key stakeholders with different backgrounds), consultation with the prospective members of the European Biodiversity Partnership, the European Commission DG R&I and DG ENV services, as well as numerous research organisations and stakeholders including policy-makers through an open consultation process in January/February 2021.

The Strategic Research and Innovation Agenda identifies **three Topical Themes** and associated knowledge needs, and **two Cross-cutting Themes** dealing with general issues that are relevant to all the Topical Themes. It should be made clear that these themes will not necessarily translate into specific Flagship Programs and/or calls for projects, as these could correspond to a combination of Topical and Cross-cutting Themes.



In addition, the European Biodiversity Partnership recognizes the need to deal with trans-sectoral issues by liaising with **well-established entities, other European initiatives** (such as other Partnerships and initiatives emerging in the context of Horizon Europe), **key international initiatives**, and a broad range of stakeholders – including private sector, managers of natural resources and of protected areas, civil society organisations, and citizens. The European Biodiversity Partnership will also contribute to several Horizon Europe missions (including those related to Soil; Climate; and Seas and Oceans). By efficiently implementing a well-defined Strategic Research and Innovation Agenda while maintaining a high level of openness, the European Biodiversity Partnership will be a cornerstone in the **EU's long-term strategic research agenda for biodiversity**.

We sincerely thank all the BiodivERsA/European Biodiversity Partnership members, European Commission services, scientists, research organisations and platforms, policy makers and stakeholders who have contributed to the development of this Strategic Research and Innovation Agenda, which is a milestone for the build-up of **a reinforced 'European Research Area' on biodiversity, at the right level in the context of Horizon Europe and the pressing environmental and societal issues that we increasingly perceive**.

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1. INTRODUCTION

1.1. THE CHALLENGE

BIODIVERSITY STATUS & TRENDS, AND THEIR IMPLICATIONS FOR PEOPLE GLOBALLY

Biodiversity (biological diversity at the genetic, species and ecosystem levels[3]) and nature's contributions to people[4] are our common natural heritage, which has intrinsic value and underpins our health and quality of life, livelihoods, food security/diverse diets and economies. Yet, the Global Assessment released by the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES)[5] as well as other studies and syntheses[6] show that biodiversity is declining globally at rates unprecedented in human history while the pressures driving this decline are intensifying. Indeed, 75% of the terrestrial environment, 40% of the marine environment and 50% of rivers and streams are severely altered due to human activity and the rate of species extinctions is accelerating, with major impacts on goods and services provided by nature and major consequences for people around the world. For example, up to US$577 billion in annual global crops are at risk from pollinator loss, and 100-300 million people are at increased risk of floods and hurricanes because of loss of coastal habitats. The production patterns, increase in human population with unsustainable consumption, and rapid urbanization projected in the coming decades are expected to lead to growing demand for resources, posing significant conflicts for land and risks to biodiversity and impacting human well-being and health (including increased risk of new zoonotic diseases spilling over into humans, see Box 1), economy and social equity.

BOX 1: THE IMPORTANCE OF THE RELATIONSHIPS BETWEEN BIODIVERSITY AND HUMAN HEALTH

In recent decades, zoonotic diseases – diseases transferred from animals to humans– have gained international attention. Ebola, avian influenza, H1N1 flu virus, Middle East respiratory syndrome, Rift Valley fever, Sudden Acute Respiratory Syndrome, West Nile virus, Zika virus, and now the coronavirus SARS-Cov-2 have all caused or threatened to cause major pandemics, with millions of deaths and billions in economic losses.

High biodiversity areas may play host to a larger pool of pathogens, but high biodiversity areas in healthy condition can hold those pathogens in check. Human impingement on natural habitats, biodiversity loss and ecosystem degradation are making pathogen spillover events much more likely[7]. Habitat destruction reduces the habitat availability for wildlife to the extent that they need to resort to human settlements. As people move further into the territories of wild animals to clear forests, raise livestock, hunt and extract resources, they are increasingly exposed to pathogens and their reservoirs/vectors, which increases the

3. According to the Convention on Biological Diversity, "biodiversity" is defined as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (United Nations Convention on Biological Diversity 1992)

4. Nature's contributions to people (NCP) are all the contributions, both positive and negative, of living nature (i.e. diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to the quality of life for people. Beneficial contributions from nature include such things as food provision, water purification, flood control, and artistic inspiration, whereas detrimental contributions include disease transmission and predation that damages people or their assets. Many NCP may be perceived as benefits or detriments depending on the cultural, temporal or spatial context (Diaz et al. 2018 - Science 359, 270–272)

5. IPBES (2019) Global Assessment Report on Biodiversity and Ecosystem Services (https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf)

6. Blowes S.A. et al. (2019) The geography of biodiversity change in marine and terrestrial assemblages. Science 366, 339–345 ; Convention on Biological Diversity (2020) Global Biodiversity Outlook 5 (https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf)

7. Johnson C.K. et al. (2020) Global shifts in mammalian population trends reveal key predictors of virus spillover risk. Proc. Royal Soc. B; IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany. DOI:10.5281/zenodo.4147317

likelihood of pathogen transfer to humans. Ecosystem disruption also has an impact on how pathogens behave in the wild. So-called "wet markets" selling meat and live animals provide another incubator for the emergence of infectious diseases.

Decreasing species diversity has also been linked to increasing disease outbreaks. For example, decreasing mammal diversity has been linked to increasing prevalence of infection in ticks, because the dilution effect is lost, and consequently the risk of human exposure to Lyme disease increases.

The health of animals, the ecosystems and humans are all interlinked (One Health/Ecohealth approach), and when one is out of balance, others follow suit[8]. To cope with pandemics, a holistic approach will thus be needed not only focusing on reducing disease spread, development of vaccines and improved healthcare but most notably on tackling the root causes of its origin: biodiversity degradation and altered human-nature relationships. In addition the numerous health benefits derived from nature including from urban green spaces should receive greater attention[9].

In addition, a Intergovernmental Panel for Climate Change (IPCC) Special Report issued in 2018[10] asserts that a global warming of 1.5 °C would lead to devastating impacts on biodiversity and the ecosystem services it provides. Overall, the main causes of biodiversity decline are changes in land and sea use by humankind, direct exploitation of organisms, climate change, pollution, and invasive alien species. Several of those causes also aggravate climate change. Therefore, despite progress to conserve nature, global goals for conserving and sustainably using nature cannot be met by current trajectories. Goals for 2030 and beyond may only be achieved through fast, systemic and transformative changes across economic, social, political and technological sectors, going far beyond incremental changes and including a clear shift in mind-set. Given the lack of progress on most of the twenty Aichi Biodiversity Targets reported in the recent Global Biodiversity Outlook 5[11], it is clear that we have failed to deliver on key commitments by the 2020 deadline. The current negative trends in biodiversity will undermine progress towards not only Targets 14 (oceans) and 15 (land) but many of the targets of the Sustainable Development Goals (SDGs)[12] related to poverty, hunger, health, water, cities and climate (SDGs 1-3, 6, 11, 13) which all strongly depend on good biodiversity status[13] (Fig. 1).

8. in 2018, BiodivERsA launched a call on 'biodiversity & health'; 2 funded projects study wild animal reservoirs of viruses, including coronaviruses (see https://www.biodiversa.org/1643)

9. IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany. DOI:10.5281/zenodo.4147317

10. IPCC (2018) Special Report on the impacts of global warming of 1.5°C (https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf)

11. Convention on Biological Diversity (2020) Global Biodiversity Outlook 5 (https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf)

12. Blicharska M. et al. (2019) Biodiversity's contributions to sustainable development. Nat Sustain 2, 1083–1093. See also: https://sustainabledevelopment.un.org/?menu=1300

13. United Nations Environment Programme (2021). Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi. (https://www.unep.org/resources/making-peace-nature)

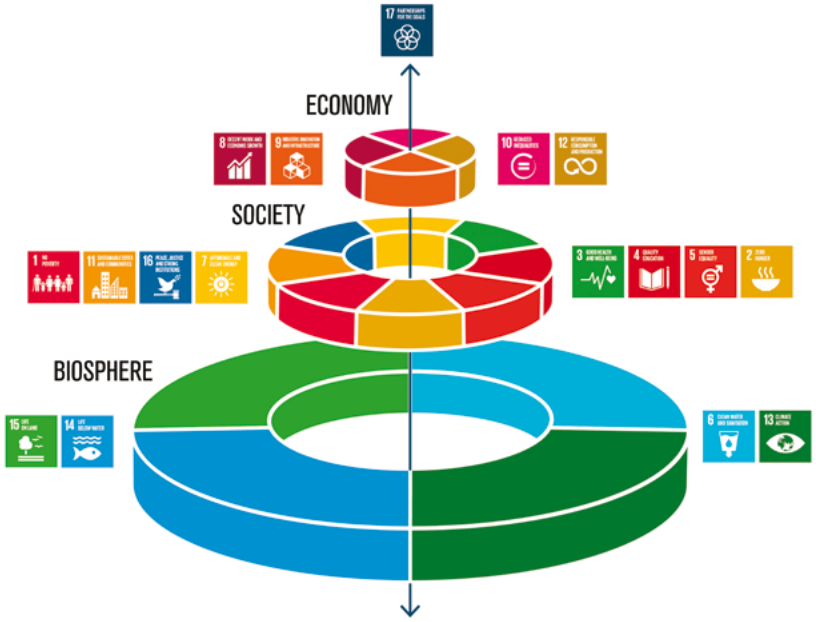

Figure 1: A good status of biodiversity is the basis for sustainable development and a pre-requisite to achieve the Sustainable Development Goals (from Rockström and Sukhdev at 2016 EAT Forum; Azote Images for Stockholm Resilience Centre, Stockholm University).

Loss of biodiversity is therefore not only an environmental issue, but also a developmental, economic, security, health, social and ethical issue. This is illustrated by the recently released Global Risks Report 2021[14] that identifies biodiversity loss and ecosystem collapse within the top five of major threats that may impact global prosperity in 2021 and over the next decade.

BIODIVERSITY STATUS AND TRENDS, AND THEIR IMPLICATIONS FOR PEOPLE IN EUROPE

The IPBES Regional Assessment for Europe and Central Asia[15] shows that biodiversity in Europe follows this global trend of strong decline (Fig. 2), with major impact on the contributions it provides to people. Economists estimate that the loss of biodiversity in Europe costs the EU around 3% of GDP per year[12]. Similarly, about 15 billion of the EU's annual agricultural output is directly attributed to insect pollinators[16]. The EU has an extensive legal and policy framework aimed to protect, restore and sustainably manage its natural habitats, species and ecosystems[17] and to integrate biodiversity across EU policies and instruments[18]. However, the latest 2020 State of Nature in the EU report[19] shows that Europe's biodiversity continues to decline at an alarming rate, with most protected species and habitats found not to have a good conservation status. Overall, the state of species and habitats is the same

14. The World Economic Forum (2021) The Global Risks Report 2021 (http://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf)

15. IPBES (2018) The regional assessment report on biodiversity and ecosystem services for Europe and Central Asia (https://www.ipbes.net/sites/default/files/spm_2b_eca_digital_0.pdf)

16. https://www.europarl.europa.eu/news/en/press-room/20191212IPR68921/bees-meps-call-for-reduction-in-use-of-pesticides-to-save-europe-s-bees

17. In particular the EU Birds Directive (2009/147/EC), the EU Habitats Directive (92/43/EEC), the EU Water Framework Directive (2000/60/EC), the EU Marine Strategy Framework Directive (2008/56/EC) and the EU Invasive Alien Species Regulation (Regulation (EU) No 1143/2014)

18. In particular the EU policies in the areas of research and innovation, agriculture, fisheries, climate, energy, transport, regional development, development cooperation and trade

19. European Commission (2020) State of Nature in the European Union – Report on the status and trends in 2013-2018 of species and habitats protected by the Birds and Habitats Directive (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0635&from=EN)

or poorer than in 2015. This threatens the delivery of ecosystem services e.g. linked to the Natura 2000 network, which are estimated to be worth up to 300 billion euros a year[20]. Furthermore, the first EU-wide assessment of ecosystems[21] shows deteriorating trends for most of the main ecosystem types across the EU, and concludes that the current potential of ecosystems to deliver timber, protection against floods, crop pollination and nature-based recreation is equal to or lower than the baseline value for 2010. As Parties to the Convention on Biological Diversity, the EU and its Member States have adopted a series of strategies and action plans aimed at halting and reversing the loss of biodiversity, including the new EU Biodiversity Strategy to 2030[1].

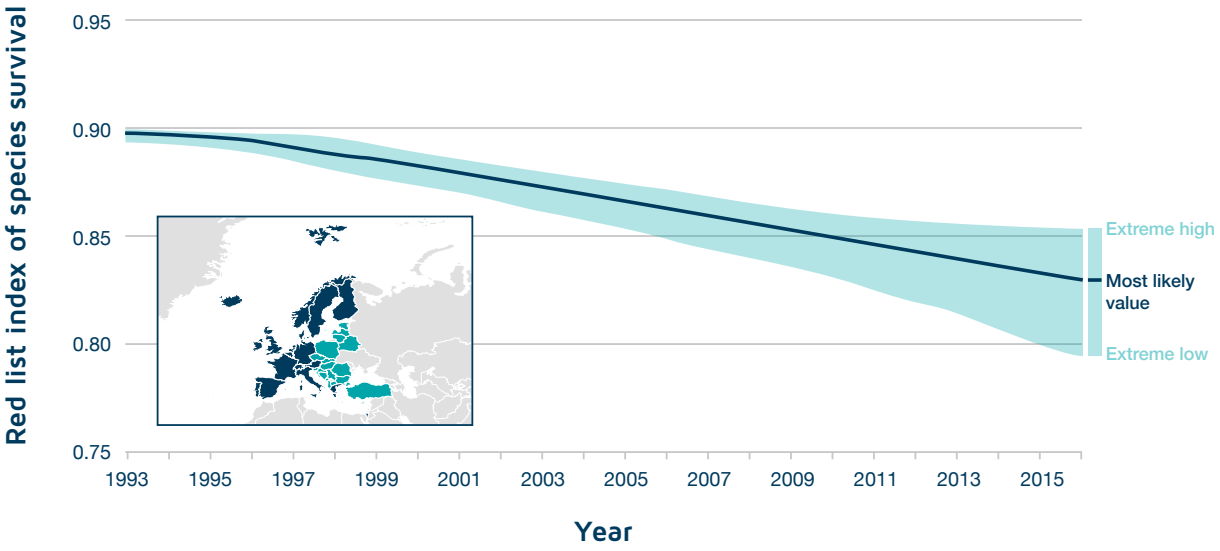

Figure 2: Trend in Red List Indices of species survival (aggregated for birds, mammals and amphibians) within Central and Western Europe. The position on the vertical axis indicates the risk of extinction (the closer to one the lower the aggregate extinction risk). Modified from IUCN, in: IPBES (2018)[15].

The main drivers of biodiversity loss however persist and many are on the increase. Funding and capacity to tackle the root causes are insufficient, and barriers to integration remain.

IMPACT OF THE EU ON BIODIVERSITY BEYOND ITS BORDERS

Already ten years ago, EU agricultural and biofuel policies were noted to have visible impacts on land use and biodiversity loss beyond its borders, for instance in Brazil[22]. In the years since, it has been increasingly recognized that EU impacts biodiversity beyond its borders, in particular due to deforestation and climate change[23]. This poses an important challenge to biodiversity conservation, since export industries continue to drive overexploitation of nature, hampering conservation efforts.

Conservation and restoration research and measures must therefore consider not just the point of impact, but also the (consumer) demand that ultimately drives resource use across the globe.

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20. FACTSHEET – The Economic Benefits of Natura 2000 (https://ec.europa.eu/environment/nature/natura2000/financing/docs/Economic%20Benefits%20Factsheet.pdf)

21. JRC (2020) Mapping and Assessment of Ecosystems and their Services: an EU ecosystem assessment (https://publications.jrc.ec.europa.eu/repository/bitstream/JRC120383/eu_ecosystem_assessement_final.pdf)

22. Prins A.G. et al. (2011) Global Impacts of European Agricultural and Biofuel Policies. Ecol. Soc. 16: 1

23. Crenna E. et al. (2019) Biodiversity impacts due to food consumption in Europe. J. Cleaner Prod. 227, 378-391; Marques A. et al. (2019) Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth. Nat. Ecol. Evol. 3, 628–637

BIODIVERSITY: A FUNDAMENTAL ASSET FOR NATURE-BASED SOLUTIONS TO SOCIETAL CHALLENGES

Keeping in mind the interests of the current and future generations, biodiversity is a common good, a natural heritage and public good to conserve as a moral duty, but also a fundamental asset for Nature-based Solutions tackling numerous societal challenges (such as water and food security, energy supply, health and well-being, climate change, peace and equity[24]). Nature-based Solutions are cost-effective solutions that are inspired and supported by nature, simultaneously providing environmental, social and economic benefits and helping build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions[25]. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services. The idea underlying Nature-based Solutions is that, subject to appropriate epistemological and ethical precautions, the ecological performance and resilience capacity of biologically diverse ecosystems must be considered when searching for sustainable solutions to tackle societal challenges. Provided that they have not lost important species and genetic diversity, semi-natural and natural habitats harbour genetic and functional variation within and amongst species which have evolved under natural selection during varying climatic conditions for thousands of years. Furthermore, this natural selection and co-adaptation of species, supported by their genetic variation, has occurred on-site, yielding local adaptations. Thus, as highlighted in the statements at the United Nations' Climate Action Summit in September 2019, it is increasingly recognised that biodiversity is also a major asset to innovate and develop solutions tackling many challenges our society faces. Nature-based Solutions are a fundamental part of action for climate and other societal challenges. For instance, Nature-based Solutions could provide over one-third of the cost-effective climate mitigation needed between now and 2030 to stabilize global warming below +2°C, achieving nature's mitigation potential of 10-12 gigatons of CO2 per year[26]. As part of the portfolio of possible actions, adequate investment in Nature-based Solutions can also help achieving climate change adaptation, disaster risk-reduction, better health, halt of land degradation, reinforced sustainability of businesses and sectors like agriculture, forestry, fisheries and infrastructures, and better human well-being and quality of life including in cities, while simultaneously contributing to the conservation and sustainable use of biodiversity[27]. Clearly, investing in Nature-based Solutions is a crucial and smart strategy, complementary to other strategies that make less use of biodiversity or fully rely on technological innovations, to reach the goals of the UN SDGs, the Paris Agreement, the Sendai Framework on Disaster Risk Reduction, and Biodiversity Strategies at all levels.

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24. United Nations Environment Programme (2021). Making Peace with Nature: A scientific blueprint to tackle the climate, biodiversity and pollution emergencies. Nairobi. (https://www.unep.org/resources/making-peace-nature)

25. https://ec.europa.eu/research/environment/index.cfm?pg=nbs

26. UNEP (2017) The Emissions Gap Report 2017 (https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf); IPBES (2019) Global Assessment Report on Biodiversity and Ecosystem Services (https://ipbes.net/sites/default/files/2020-02/ipbes_global_assessment_report_summary_for_policymakers_en.pdf)

27. IPBES (2018) Assessment Report on Land Degradation (https://www.ipbes.net/system/tdf/spm_3bi_ldr_digital.pdf?file=1&type=node&id=28335);

THE BUSINESS CASE OF BIODIVERSITY

The value of biodiversity is still underrated and therefore biodiversity concerns are often considered unimportant or even disturbing in economy, trade policy and development decision-making. Investment decisions in different sectors regularly fail to take their potential impacts on biodiversity into account or to recognise the potential contribution that biodiversity can make to their desired achievements. Economies depend on ecosystems. When ecosystems collapse economies will fail, hence it is important to change the currently prevailing narrow paradigm of economic growth into a wider paradigm of a green sustainable economy. The green economy is an important area for job growth, as reiterated in various European Commission initiatives calling on Member States to invest in 'green skills' and identifying the green economy as one of three economic sectors with the strongest potential for job growth[28]. However, the potential for biodiversity to affect and be affected by economic development and processes still largely remains overlooked[29]. The need for including natural capital into public and private accounting and reporting systems is therefore crucial. The integration of the business environment into conservation and restoration of biodiversity is a challenge per se. The business case should be built around a narrative that describes the importance and value of biodiversity and ecosystem services for private sectors, which needs to be backed by compelling scientific evidence. A widely accepted, science-based methodology to integrate ecosystems and their services into decision making, to value ecosystems and to characterize the biodiversity footprint of human activities (including guidance on natural capital assessment for businesses) is instrumental in this respect. Meanwhile, a clear and robust trans-European value chain on biodiversity valorisation could foster biodiversity added value recognition and produce innovation and competitiveness and employment. Overall, and as stated by the President of the European Commission Ursula von der Leyen in her 'Agenda for Europe'[30], "*those who act first and fastest will also be the ones who grasp the opportunities from the ecological transition*".

28. SBEnrc (2012) Can biophilic urbanism deliver strong economic and social benefits in cities? An economic and policy investigation into the increased use of natural elements in urban design (http://eprints.qut.edu.au/85922/1/sbenrc_1.5biophilicurbanism-industryreport.pdf)

29. Dasgupta, P. (2021), The Economics of Biodiversity: The Dasgupta Review. (London: HM Treasury) (http://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf)

30. https://ec.europa.eu/commission/sites/beta-political/files/political-guidelines-next-commission_en.pdf

NEED FOR TRANSFORMATIVE CHANGE

The IPBES Global Assessment revealed that action at the level of direct drivers of nature decline, although necessary, is not sufficient to prevent further biodiversity degradation[5,31]. Reversal of biodiversity loss is only possible with urgent transformative change that tackles the root causes of biodiversity loss and linked challenges including climate change, urbanization, food and fiber production, and health: i.e. the interconnected economic, socio-cultural, demographic, political, institutional, and technological indirect drivers behind the direct drivers (Fig. 3).

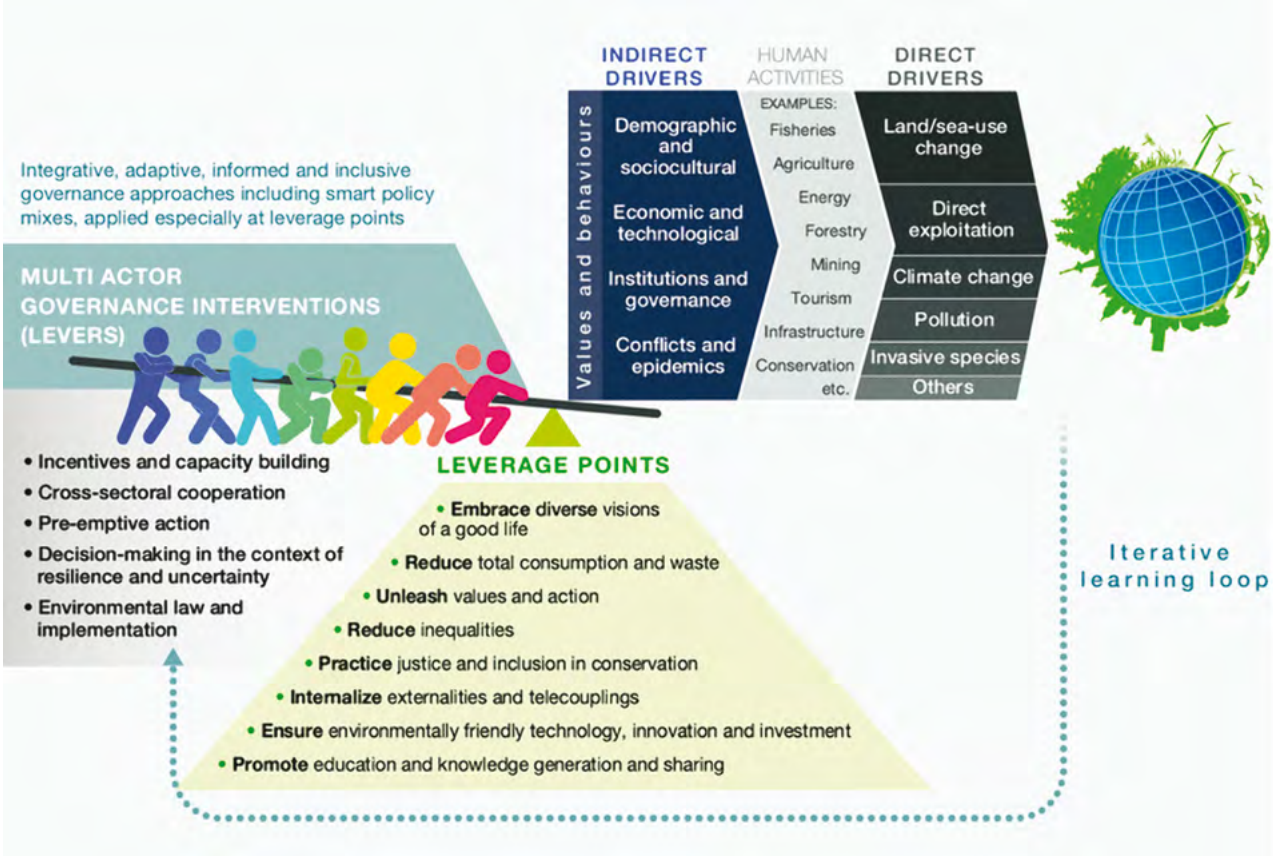

Figure 3: Enabling transformative change to tackle the biodiversity crisis. Collaborative implementation of priority interventions (levers) targeting key point of intervention (leverage points) could enable transformative change from current trends toward more sustainable ones. This requires innovative governance approaches and actions around nexuses, representing closely interdependent and complementary goals (IPBES 2019)

This transformation will need a cross-sectoral approach ensuring policy coherence and effectiveness, as well as innovative governance approaches that are adaptive (learning, monitoring and feedback); inclusive (right-based and reflecting a plurality of views and ensuring equity); informed by existing and new evidence; and integrative across systems, jurisdictions, and tools. Research and Innovation in the biodiversity domain will thus need to recognize that ecological, social and technological changes go hand in hand and co-evolve, and to focus on this alignment and breakdown of silos. It should also bring issues such as civil society participation (e.g. citizen science) and co-production of knowledge with stakeholders more centrally into the frame. Further it should promote effective communication on biodiversity issues to achieve improved awareness of the multiple benefits of biodiversity.

31. Diaz S. et al. (2019) Pervasive human-driven decline of life on Earth points to the need for transformative change. Science 366, 6471

INCREASED AWARENESS AT HIGH POLITICAL LEVEL

With the scientific evidence currently available, based on observations and modelling in particular, it seems humanity is on the verge of the same awakening to the biodiversity crisis as the one we are witnessing on climate change. For instance, the state of environment report 2020 for Europe[32] indicates that Europe will not achieve its 2030 goals spelled out in the EU Biodiversity Strategy to 2020 without urgent action during the next 10 years to address the alarming rate of biodiversity loss, increasing impacts of climate change and the overconsumption of natural resources. This is underlined in the vision the President of the European Commission has promoted for Europe (Box 2). As a direct response, an important place to biodiversity issues is allocated in the document presenting the orientations towards the first Strategic Plan for Horizon Europe , in particular regarding investments in research and innovation concerning food, bio-economy, natural resources, agriculture and environment (Cluster 6).

BOX 2: VISION OF THE PRESIDENT OF THE EUROPEAN COMMISSION URSULA VON DER LEYEN REGARDING THE NEED TO PRESERVE EUROPE'S NATURAL ENVIRONMENT, PART OF THE POLITICAL GUIDELINES FOR THE NEXT EUROPEAN COMMISSION[33,34]

"*Climate change, biodiversity, food security, deforestation and land degradation go together. We need to change the way we produce, consume and trade. Preserving and restoring our ecosystem needs to guide all of our work. We must set new standards for biodiversity cutting across trade, industry, agriculture and economic policy.*

As part of the European Green Deal, we will present a Biodiversity Strategy for 2030.

Our environment, our natural jewels, our seas and oceans, must be conserved and protected. Europe will work with its global partners to curtail biodiversity loss within the next five years. I want us to lead the world at the 2020 Conference of the Parties to the Convention on Biological Diversity, just as we did at the 2015 Paris Climate Conference."

'*Halting biodiversity decline and restoring ecosystems through improved knowledge and innovative solutions contributing towards reaching the global vision for biodiversity 2050*'[35] represents one of the major targeted impacts in this context. This should be echoed in the 8th Environmental Action Program planned to be adopted in 2021[36], embracing and complementing the Green Deal while including measures to help reach the SDGs in 2030. Parties of the Convention on Biological Diversity are currently preparing for a post-2020 global biodiversity framework that aims to reinforce the three objectives of the Convention on Biological Diversity and to set high ambition for biodiversity conservation and ecosystem restoration, ecosystem connectivity, ecological restoration, avoid ecosystem degradation and safeguard and enhance biodiversity and nature contributions to people at all levels. In Europe, the New Strategic Agenda for 2019-2024[37] adopted by the European Council commits to lead efforts to stop

32. European Environment Agency (2020) The European Environmental – State and Outlook 2020: knowledge for transition to a sustainable Europe (https://www.eea.europa.eu/soer-2020/)

33. https://ec.europa.eu/info/sites/info/files/research_and_innovation/strategy_on_research_and_innovation/documents/ec_rtd_he-orientations-towards-strategic-plan_102019.pdf

34. files/political-guidelines-next-commission_en.pdf

35. European Commission (2020) EU Biodiversity Strategy for 2030 – Bringing nature back into our lives (https://eur-lex.europa.eu/resource.html?uri=cellar:a3c806a6-9ab3-11ea-9d2d-01aa75ed71a1.0001.02/DOC_1&format=PDF)

36. European Commission (2020) Proposal for a decision of the European Parliament and of the Council on tha General Union Environmental Action Program to 2030 (https://ec.europa.eu/environment/strategy/environment-action-program-2030_en)

37. https://www.consilium.europa.eu/media/39914/a-new-strategic-agenda-2019-2024.pdf

the loss of biodiversity and preserve and restore ecosystems. In the EU –for both the European Commission and Member States– research is pivotal and necessary to meet the obligations of the Habitats Directive's articles 2, 10 and 18 by, for example, tailoring/adapting the conservation and restoration measures to achieve maximum efficiency at overarching, regional and local levels. The G7/ G20 declarations and the World Economic Forum[38] also underlined the need to halt biodiversity loss, which further demonstrates that this issue is now recognized also at the highest political level. And the Covid-19 crisis has reminded us of the relationship between drivers of biodiversity loss and human health.

NEW NEEDS IN TERMS OF BIODIVERSITY RESEARCH

Facing the current biodiversity crisis and its multiple drivers, it is needed to reinforce the science-based knowledge on biodiversity status, dynamics and trends; on the multiple and interacting causes and consequences of biodiversity loss and degradation of ecosystem services; and on levers of action. Moreover, to safeguard biodiversity for future generations, it is crucial to increase knowledge and develop pathways to ensure the continuation of ecological and evolutionary processes – both within species and at an ecosystem level. An effective science-policy-practice interfacing is also important to foster cost-effective measures and management options for maintaining and restoring our natural capital while respecting the planetary boundaries. Research is needed to develop and assess novel tools and approaches to biodiversity conservation, restoration and sustainable management, including Nature-based Solutions; to develop guidelines to promote biodiversity-friendly standards and practices across different sectors; and to underpin the ability to measure and communicate progress towards the upcoming targets of policy agendas. Furthermore, in order to efficiently tackle the interdependent biodiversity and climate crisis, both issues need to be tackled in an integrated manner, mobilizing research communities from across disciplines from life sciences, earth sciences, social sciences and humanities, and a broad range of stakeholders. To achieve all of this, it is imperative to support academically excellent research that forms the basis to inform and support policy makers and other stakeholders with reliable knowledge, and to properly invest in capacity building and training.

38. https://www.weforum.org/agenda/2020/01/nature-risk-biodiversity-climate-ocean-extinction-new-deal/

2. THE EUROPEAN BIODIVERSITY PARTNERSHIP: AMBITION AND EXPECTED IMPACTS

2.1. PREVIOUS FRAMEWORK INTERVENTIONS AND RESULTS

Biodiversity-related Research & Innovation, including basic and applied research, training, infrastructures and demonstrators, have been addressed over successive EU research framework programs. But the percentage of biodiversity research funding by the European Commission compared to its total expenditures to research has historically fluctuated through the different funding cycles. After a decline in biodiversity funding in the aftermath of the 2008 financial crisis[39], a considerable funding effort has been made in Horizon 2020, notably in the areas of Nature-based Solutions[40] and ecosystems restoration[41], but also through bottom-up programmes, such as the ERC[42] to increase that percentage to an estimated 4% of the whole programme. There have also been several key initiatives funded under Horizon2020 to interconnect science and policy, such as Oppla (EU Repository of Nature-based Solutions); EKLIPSE (the Knowledge & Learning Mechanism on Biodiversity & Ecosystem Services); and ThinkNature and its successor NetworkNature (Multistakeholder Platform on Nature-based Solutions). Noticeably, the Framework Program created by the European Union to support and foster research in the European Research Area has also allowed funding a set of research and demonstration projects (Innovation Actions and Research Innovation Actions) on Nature-based Solutions. Recognizing that mapping and assessment of ecosystems and their services in the EU and its Member States are core to support the implementation of the EU Biodiversity Strategy to 2020, the MAES (Mapping and Assessment of Ecosystems and their Services) initiative was launched in 2012. Throughout its development, MAES benefited from the activities implemented by several projects such as OpenNESS, OPERAs, and ESMERALDA aiming at delivering a flexible methodology to provide the building blocks for pan-European and regional assessments of biodiversity and ecosystem services; MOVE/MOVE-on for mapping and assessing the benefits coming from the European overseas' ecosystems; MAIA (Mapping and Assessment for Integrated ecosystem Accounting) aiming at mainstreaming natural capital and ecosystem accounting in EU Member States; and the KIP-INCA (Knowledge Innovation Project on Natural Capital Accounting) developing an integrated natural accounting system for ecosystems and their services and associated data sets. In addition, the European Commission has supported Joint Programming on biodiversity, ecosystem services and Nature-based Solutions through BiodivERsA since 2005.

2.2. BUILDING ON PREVIOUS PARTNERSHIPS AND RESULTS

This European Biodiversity Partnership will build on the efficient structuring of the European Research Area in the domain achieved by BiodivERsA which, from 2005 onwards, has demonstrated the openness, long-term financial commitment and flexibility needed to have the required impact. The BiodivERsA network has continuously expanded, from 13 Member states and Associated Countries in 2005 to 25 in 2019. It now gathers 39 Ministries, agencies and foundations, and in 2015 BiodivERsA joined forces with members of the former NetBiome network to also mobilize local authorities in Outermost Regions

39. Goudeseune L. et al. (2018) The BiodivERsA database: a mapping of research on biodiversity and ecosystem services in Europe over 2005-2015. BiodivERsA Report 66 pp (https://www.biodiversa.org/1655/download)

40. At least 243 million € were invested in the NBS research portfolio between 2016 and 2020. Naumann S. et al. (2020) Nature-based Solutions: state of the art in EU-funded projects. Independent Expert Report. European Union, 2020 (https://op.europa.eu/s/pcyt)

41. 80 million € in the 2020 Green Deal call, area 7, topic 1 "Restoring biodiversity and ecosystem services" (https://europa.eu/!MV66fr) . Projects awarded in 2021.

42. EU investments in biodiversity-related research during Horizon 2020 are up to EUR 2.6 billion (approximately 4% of the whole programme), as estimated using the OECD Rio markers methodology. This includes basic and applied research, training, infrastructures, ecosystem-based approaches and nature-based solutions.

(ORs) and Overseas Countries and Territories (OCTs). BiodivERsA has demonstrated its capacity to support researchers that have high levels of excellence both in terms of academic outputs and policy/society relevance and impacts[43]. In addition, BiodivERsA has developed an approach allowing concrete and successful participation for many EU13 countries. The European Biodiversity Partnership will also build on BiodivERsA's experience in promoting coherent science-policy/science-society interfacing at all stages of the research process. This approach allows engaging with stakeholders from policy, society and business in the strategic programming, implementation and dissemination of research. Over the last few years, it has led to close and mutually beneficial collaborations with stakeholders both at the program level and at individual projects' levels[41,44]. This has resulted in impacts for society and decision-making, often based on findings from co-developed research projects. It has also led to fruitful collaborations with private economic actors whose activities depend on natural resources, although the successful collaborations with large businesses would require further attention. Overall, BiodivERsA had a range of impacts[45], which includes:

» build-up of a strong ERA on biodiversity, with 39 partners from 25 countries corresponding to ca. 75% of the funding capacity of biodiversity R&I in Europe[40];

» key contributions to the emergence of the R&I agenda on Nature-based Solutions through contribution to framing the concept, disseminating it in national agendas and supporting related research;

» efficient mapping of the biodiversity R&I landscape across Europe, including national and local programs for competitive funding of biodiversity research projects (over 11,500 projects referenced in a database[46]) and biodiversity research infrastructures;

» development of the BiodivERsA Strategic Research and Innovation Agenda[47] with inputs from a broad range of stakeholders, which was influential for national R&I programs in some countries and for DG R&I;

» direct support to 125 R&I pan-European projects and 2,576 researchers, for a total of 235 Mio € (including 151 Mio € in cash);

» capacity building of researchers for science-society/policy interfacing (Stakeholder Engagement Handbook, Guide on Policy Relevance, Citizen Science toolkit, etc.);

» dissemination of research results to support policy (policy briefs, contribution to IPBES assessments), private actors (innovation workshops), and a broad range of stakeholders (through OPPLA platform[48]).

Based on these achievements, the BiodivERsA members have set up the BiodivERsA Partnership through a Memorandum of Understanding in 2018. Further, BiodivERsA was selected in October 2019 to host the 'Catalysing Knowledge Generation' part of the IPBES Technical Support Unit on Knowledge and Data.

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43. Lemaitre F. & Le Roux X. (2015) Analysis of the outputs of BiodivERsA funded projects: BiodivERsA 2008 joint call on "Biodiversity: linking scientific advancement to policy and practice". BiodivERsA report, 63 pp. (http://www.biodiversa.org/889/download)

44. Lemaitre F. & Le Roux X. (2021) Analysis of the outputs of BiodivERsA funded projects: Projects completed over 2014-2018. BiodivERsA report, 55 pp.

45. Bléry C., Lemaitre F. & Le Roux X. (2018) BiodivERsA main achievements for research on biodiversity, ecosystem services and Nature-based Solutions over 2008-2018, 52 pp. (https://www.biodiversa.org/1557/download)

46. https://www.biodiversa.org/database

47. Le Roux X. et al. (2016) The BiodivERsA strategic research and innovation agenda (2017-2020). BiodivERsA 86 pp. (https://www.biodiversa.org/1226)

48. OPPLA platform: https://oppla.eu/

In addition, the European Biodiversity Partnership will continue to build on the efficient networking and collaboration achieved during the past years between partners of MAES and of MOVE. These projects provided a knowledge base on ecosystems and their services with a coherent analytical framework as well as common definitions and typologies for clustering habitats and mapping of ecosystems and a typology of ecosystem services for accounting, to be applied by the EU and its Member States, ORs and OCTs. The strong connection between MAES and the European Biodiversity Partnership would facilitate its continuity, implementation by EU Member States and upscaling (pan-European, global) in the long-term. It could reinforce the visibility of MAES science-policy role for informing policy while being more tightly linked to research agendas. With the input of the recent EuropaBON action[49] this collaboration supports the development of new methods and indicators for biodiversity and ecosystem services monitoring and wider uptake of the results. MAES could bring additional national/sub-national commitment, understanding of policy need for long-term monitoring for biodiversity/ecosystems, monitoring of whether or not the actions are commensurate to achieve the policy objectives, and mainstreaming this aspect in different sectors/stakeholders.

This European Biodiversity Partnership will thus build on already successful joint programming and cooperation, further widening the scope of members and reinforcing the link with policy makers and stakeholders (including collaboration with the private sector and citizens). The Partnership will further increase synergies between existing initiatives, tools and mechanisms, in order to move Europe towards sustainable development pathways, building on and contributing to healthy and biologically diverse ecosystems.

2.3. AMBITION AND EXPECTED IMPACTS

The members of the European Biodiversity Partnership are committed to the **Global 2050 Vision** of 'Living in harmony with nature' adopted under the Convention on Biological Diversity, and the **corresponding EU vision** that, by 2050, biodiversity and its benefits to people will be protected, valued and restored[1]. **Long-term Goals** that add up to this 2050 Vision include (Fig. 4):

» No net ecosystem loss by 2030, with species extinction risks decreasing, and abundances of threatened species and their genetic diversity increasing;

» Deployment of Nature-based Solutions at adequate scale to contribute to people needs across Europe;

» Good biodiversity status fully acknowledged as the basis for sustainable development and a green economy, and the EU leadership will be recognized in this context.

49. EuropaBON, Europa Biodiversity Observation Network: integrating data streams to support policy (https://europabon.org/)

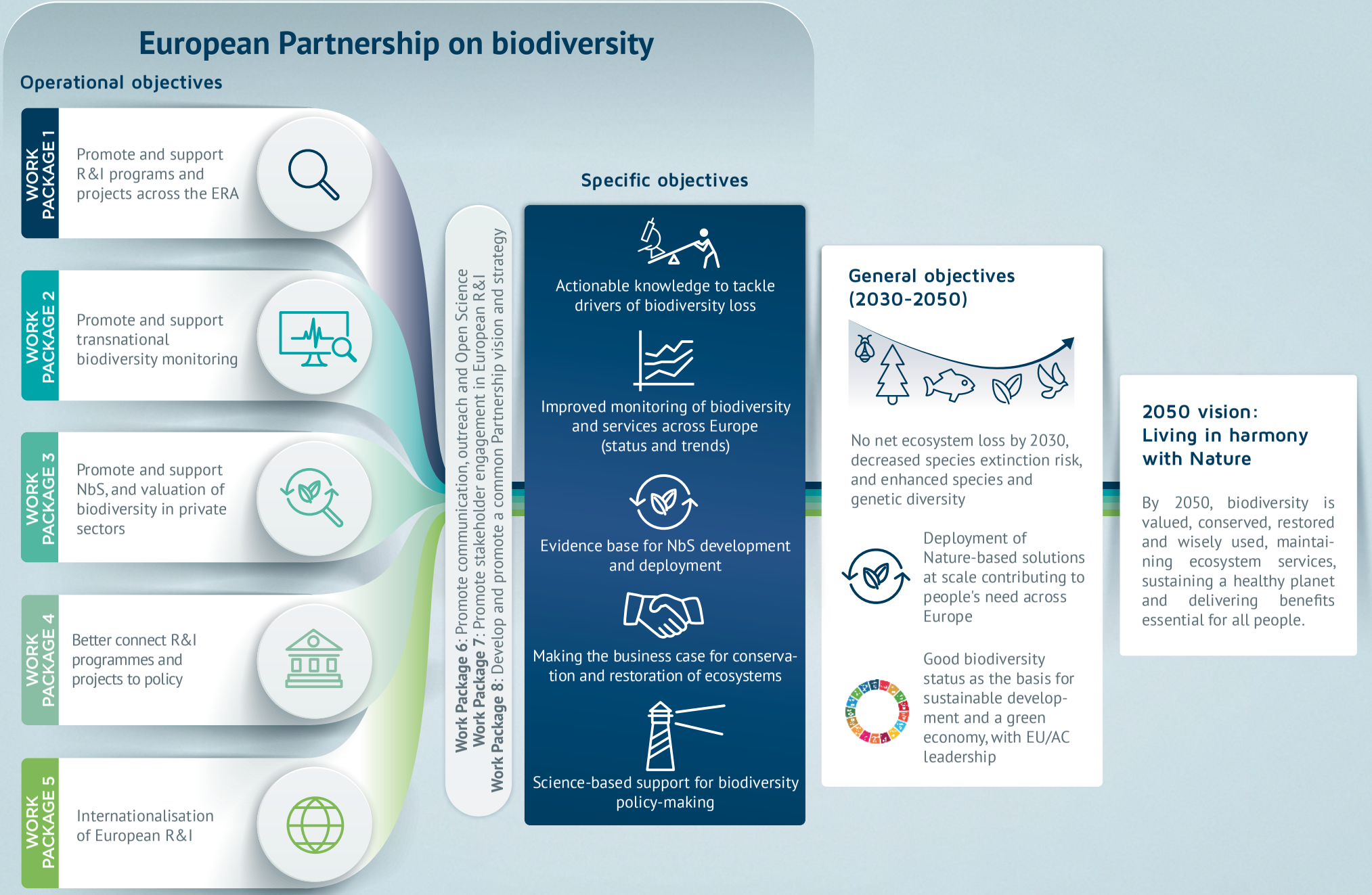

Figure 4: Summary of the (Left) working areas and (Middle) overarching objectives of the European co-funded partnership on biodiversity, which will have a key role to reach (Right) biodiversity goals for 2030 and the 2050 vision of People living in harmony with Nature. R&I: Research and Innovation.

To reach these long-term goals, the European Biodiversity Partnership will support the contribution of R&I to the EU Biodiversity strategy to 2030 to enable transformative change putting biodiversity on a path to recovery by 2030 for the benefit of climate and people. The Partnership will do this by focusing on five Overarching Objectives ("levers" to reach the 2030 Goals for biodiversity) along which impact will be generated (Fig. 4):

1. **Improved monitoring of biodiversity and ecosystem services** across all land and sea habitats in Europe (status and trends). This will build on existing national/regional monitoring schemes, capacity building for setting up new schemes, and experience from MAES-related processes with regard to enhancing and standardizing tools for mapping and assessment. The aim is a transnational network of harmonized biodiversity monitoring schemes, addressing pre-defined priorities, tightly linked to the R&I ecosystem while informing efficiently the policy arena.

2. **Actionable knowledge to tackle the drivers of biodiversity loss and ecosystem degradation**; knowledge on biodiversity status and dynamics; on drivers, pressures, impacts and responses; on trade-offs and synergies between multiple drivers of biodiversity change; and on teleconnections between world regions[50]; and assessment of novel tools and approaches to biodiversity/ecosystem conservation and restoration;

3. **Evidence base for development and deployment of Nature-based Solutions to societal challenges** in a sustainable and resilient way, hence contributing to conserve and restore biodiversity, including ecological and evolutionary processes at species and ecosystem levels, whilst also addressing multiple agendas such as fighting the climate crisis and also enhancing food and water security, and energy supply. This requires to deepen our knowledge on the relationships between biodiversity and ecosystem functioning and services. The Partnership will promote the deployment of Type1[51] Nature-based Solutions (largely based on conservation and restoration, possibly in relation with the Partnership on Blue Economy and Water4All) as a core activity, and deployment of Type2 and Type3 Nature-based Solutions (based on higher levels of intervention on ecosystems) possibly in collaboration (in particular with the Partnerships on AgroEcology Living Labs, and on Driving Urban Transitions, respectively). It also aims to assess the efficiency and cost-effectiveness of Nature-based Solutions against conventional solutions (e.g. grey infrastructure), communicating accordingly to policy makers and business decision makers;

50. Pascual U. et al. (2017) Off-stage ecosystem service burdens: A blind spot for global sustainability. Env. Res. Lett. 12 075001

51. Eggermont H. et al. (2015) Nature-based Solutions: new influence for environmental management and research in Europe. GAIA 24: 243-248

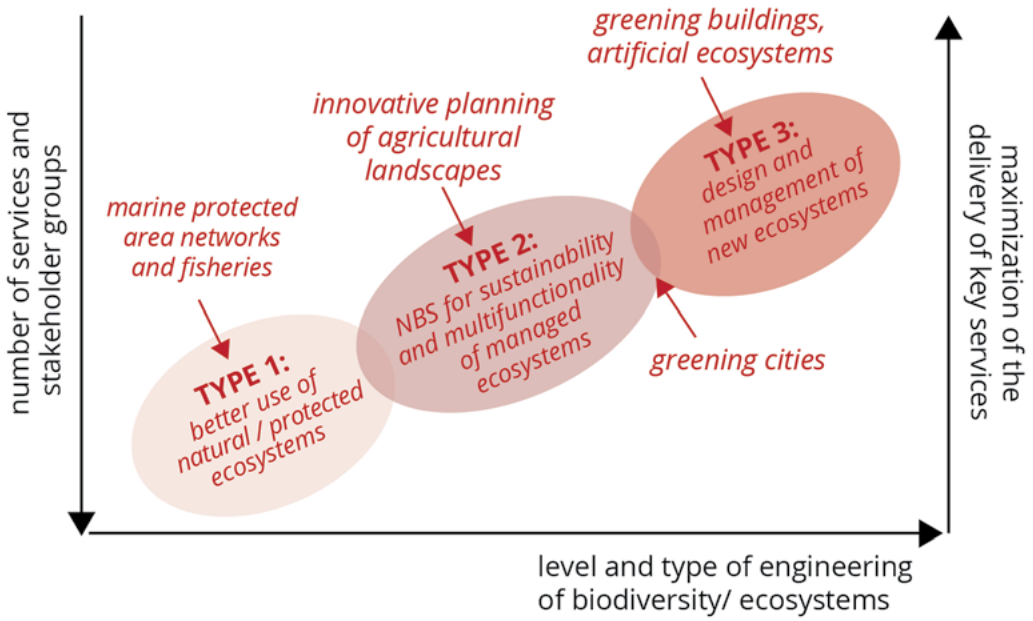

Figure 5: Typology for Nature-based Solutions according to Eggermont et al. (2015). Type 1: No or minimal interventions in ecosystems, with the objectives of maintaining or improving the delivery of a range of ecosystem services both inside and outside of these conserved ecosystems; Type 2: Management approaches that develop sustainable and multifunctional ecosystems and landscapes, with intermediate levels of intervention; Type 3: Managing ecosystems in very extensive ways or even creating new ecosystems

4. **Making the business case for biodiversity**, by contributing science-based methodologies and standards to account for and possibly value ecosystem services and the natural capital, and to assess the dependency and impact of businesses on biodiversity. The intention is to work on a few sectors and demonstrate how adequately valuing and mainstreaming biodiversity and ecosystem services into practices can make a difference in the way these sectors contribute to protect biodiversity; this should align with UN System of Environmental Economic Accounting[52].

5. **Science-based support for EU policy-making**, including for strengthening environmental policies and laws and their implementation. The Partnership will collaborate closely with the 'Knowledge Centre for Biodiversity[53]' that has been established by the EU with the JRC and EEA (cf. Objective 1) to build the corporate expertise in Europe to inform, track and assess progress in implementing the EU 2030 Biodiversity Strategy and to underpin further biodiversity policy developments. More generally, R&I programs (cf. Objective 2) will be better linked to the policy arena, allowing better informed policy-making and better assessment of policy effectiveness, efficiency and equity both within and beyond the EU border.

The two first Overarching Objectives recognize the key role of knowledge and data from natural and social sciences to tackle the biodiversity crisis. The third and fourth objectives are needed as good monitoring of biodiversity status and trends and good knowledge of societal drivers will not be sufficient to tackle the biodiversity crisis. The vision here is that bending the trend in biodiversity loss and inducing transformative changes in economy and society for the sake of biodiversity and synergies to climate change mitigation and other ecosystem services will also require coordinated investment of R&I in Nature-based Solutions, tighter links between R&I and public and private actors, and better science-based support to policy makers.

52. https://seea.un.org/content/about-seea
53. https://knowledge4policy.ec.europa.eu/biodiversity_en

2.4. KEY ISSUES FOR THE STRATEGIC RESEARCH AND INNOVATION AGENDA

The key issues to be considered for programming, funding and applying research on biodiversity and Nature-based Solutions are at least five-fold:

» In order to be effective and inclusive, biodiversity research needs to consider a multitude of criteria and stakeholder perspectives. In particular, biodiversity issues are often at the cross-roads of numerous political and socio-economic interests, which requires to account for sectors such as environment but also agriculture and fisheries, mining, transport, energy, health etc. and promote a cross-sectoral approach towards the conservation and sustainable management and use of biodiversity;

» Biodiversity research relies on disciplinary communities of high excellence which have to be supported because they create indispensable knowledge, but also requires various forms of collaboration (multidisciplinary, interdisciplinary and trans-disciplinary) often implying risks and barriers for scientists. This needs to be overcome through new forms of collaborations and exchanges[54,55]. Specific attention should be paid to the role of social sciences and humanities to inform transformation, also from an implementation and action oriented perspective;

» Biodiversity research now also includes a novel type of innovation actions based on a systemic approach to solve problems and promote a more resource efficient, greener, competitive and inclusive (i.e. accounting for diverse aspirations and values) economy, in particular by providing the knowledge needed for co-designing, co-developing and co-implementing innovative Nature-based Solutions, testing them in real-world conditions through demonstration activities and securing their market uptake. However, research actors should acknowledge that systemic approach faces more uncertainty in assessments, risk analyses, scenario analyses, and thus requires more prospective science and a precautionary approach. Overall, openness to alternative perspectives of problem solving, including new policy options, as well as a pluralistic perspective on biodiversity will remain critical to deliver more effective and socially-just conservation outcomes[56];

» Promoting adequate and rapid knowledge brokerage and transfer from research activities is increasingly needed in this context to ensure effective uptake for economic development, environment protection and societal benefits. It requires tools and skills to formulate and channel stakeholders' knowledge and to translate research outputs into societal or market value (i.e. quick translation of new findings into concrete recommendations for environmental policies and for promoting innovation);

» Biodiversity research should result in open and FAIR data, meeting the principles of findability, accessibility, interoperability and reusability. The merits of open and reproducible science to collaboration and obtaining trustworthiness (through verifiable methods and results) are many. This holds for the whole research cycle including research design (including data management plan); data collection and storage; data standardization; data preprocessing and (statistical) analysis; and distribution, publication and archivation of methods (including code and protocols). Adequate workflows with biodiversity research infrastructures should thus be ensured.

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54. Louder, E., & Wyborn, C. 2020. Biodiversity narratives: Stories of the evolving conservation landscape. Environmental Conservation, 47(4), 251-259

55. Martin, V. Y. (2020). Four common problems in environmental social research undertaken by natural scientists. BioScience, 70(1), 13-16

56. Pascual, U. et al. (2021). Biodiversity and the challenge of pluralism. Nature Sustainability – doi.org/10.1038/s41893-021-00694-7

3. TOPICAL THEMES AND CROSS-CUTTING THEMES OF THE SRIA

The European Biodiversity Partnership aims to promote the contribution of R&I to the EU Biodiversity Strategy for 2030 Strategy, and the post-2020 global biodiversity framework more generally. This translates in a Strategic Research and Innovation Agenda (SRIA) articulated around three non-mutually exclusive 'Topical Themes' suitable for the design and implementation of programs, joint calls, mobility schemes, networking, capacity building and other joint activities (Fig. 6).

The three '**Topical Themes**':

» closely align with the core themes of the EU Biodiversity Strategy to 2030, and the theory of change of the post-2020 global biodiversity framework

» are action oriented, with high societal impact

» are ground breaking for science

» are of urgency for policy and management at the European and international levels

» are comprehensive for building the overall SRIA of the Partnership, and complementary for promoting synergies between sectors, actors and policies

» are complementary and synergetic to priorities in the Horizon Europe Work Program, including relevant European Partnerships and Missions

» are supporting the EU's long-term strategic research agenda for biodiversity

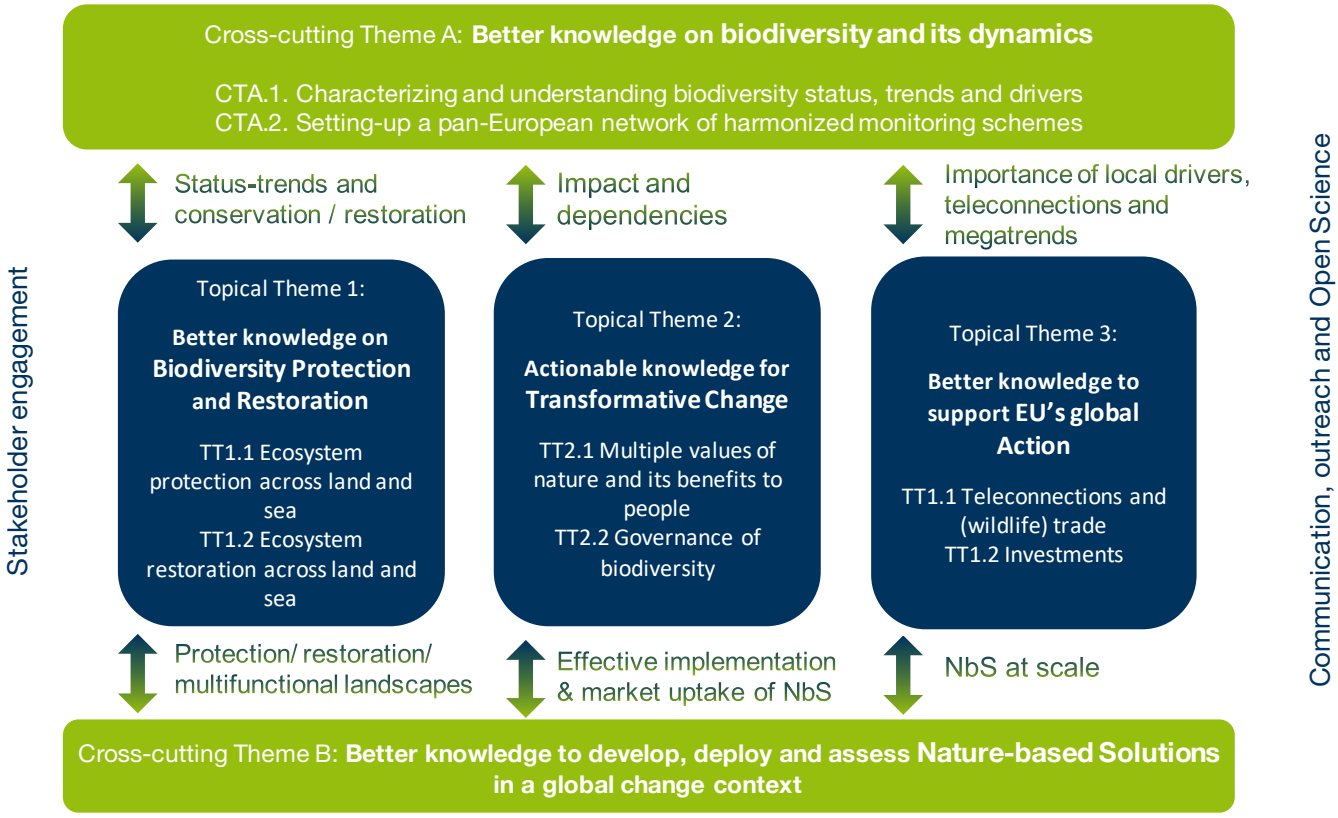

Figure 6: Overview of the Topical and Cross-cutting Themes that structure the Strategic Research & Innovation Agenda of the European Biodiversity Partnership.

The Topical Themes are complemented by two '**Cross-cutting Themes**' that are relevant to all the Topical Themes (Fig. 6).

All themes are supported by 'enabling approaches/ leverage points' including stakeholder engagement, and communication, outreach and open science to maximize impact for society and policy.

TOPICAL THEME 1

Better knowledge for biodiversity protection and restoration

RATIONALE

The EU has legal frameworks, strategies and action plans to protect and restore habitats and species. However this framework is not comprehensive, protection has been incomplete, restoration has been small-scale, and the implementation and enforcement of the legislation have been insufficient. The EU is now ready to show ambition to reverse biodiversity loss, lead the world by example and by action, and build on the headline ambition to ensure that by 2050 all of the world's ecosystems are restored, resilient, and adequately protected. Yet, protecting and restoring nature will need more than regulation alone. It will, among others, require improving and widening the network of protected areas, and establishing an EU Nature Restoration plan. In this context, and recognizing that different rationales and paths for biodiversity conservation exist (Fig. 7), fundamental inputs are expected from the research and knowledge community to deepen our understanding of the drivers of biodiversity dynamics, provide science-base guidance to actions and policies aiming at biodiversity protection and restoration, and help the rigorous assessments of their outcomes.

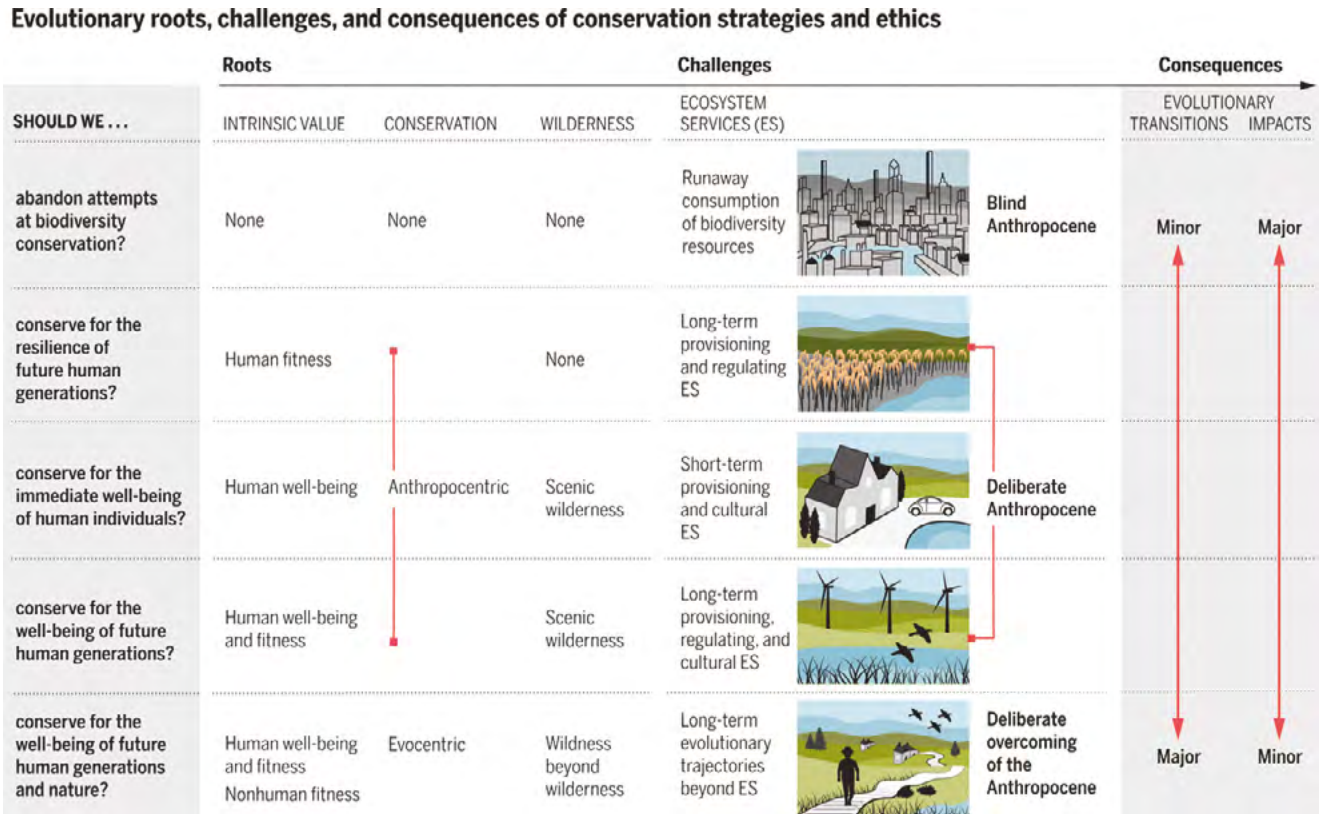

Figure 7. Different rationales and paths for biodiversity conservation exist. They are associated to different challenges and consequences for humans and non-humans (after Sarrazin F. & Lecomte 2016). This calls for a renewed research effort for clarifying and possibly seeking to expand the scope of choice available to policymakers, ultimately integrating scientific knowledge with stakeholders concerns in the form of alternative possible courses of action.

LINKS TO OTHER THEMES

The Topical Theme 1 is linked to developing, assessing and deploying Nature-based Solutions (Cross-cutting Theme B) as nature protection and nature restoration can sometimes be driven by the objective to deliver benefits such as climate regulation and adaptation, water regulation, soil health, pollination and disaster prevention and protection. Nevertheless, biodiversity has an intrinsic value, where the ecological and evolutionary processes must be protected and restored per se, explaining the importance of the Topical Theme 1. The efficiency of biodiversity protection and restoration, as well as

equity (i.e. a fair distribution of costs and benefits of the final outcome of the conservation and restoration interventions), however requires transformative action by different sectors and actors, in particular a better valuation of biodiversity and ecosystem services by these sectors and actors along with more adequate governance systems (Topical Theme 2). Given EU's influence on biodiversity outside Europe, it also requires the scaling up of conservation and restoration actions and investments beyond the EU borders (Topical Theme 3). Finally, assessing the outcomes of conservation and restoration actions and policies requires to advances in the monitoring of biodiversity and condition of ecosystems. Though the EU Mapping and Assessment of Ecosystems and their Services (MAES) initiative had made methodological progress to comprehensively map, monitor, assess and achieve good ecosystem condition, there are still significant data gaps, especially with regard to status and trends of biodiversity itself[57] (Cross-cutting Theme A).

EXPECTED IMPACTS

The European Biodiversity Partnership activities[58] under this theme will allow for more coherent conservation and restoration plans, including spatial planning of sea- and landscapes, accounting for ecological, economic and social considerations in a global change context. It will generate important scientific breakthroughs about our understanding of the biotic and abiotic determinants (and their interactions) of biodiversity dynamics depending on conservation and restoration approaches. It will provide actionable knowledge for scaling-up conservation and restoration approaches. It will also reinforce our capacity to identify and analyse the synergies and trade-offs between the diverse benefits of conservation and restoration actions, as between different stakeholders. This knowledge will be used to analyse different options to distribute the costs and benefits of conservation and restoration (including cost of inaction), and avoid simplistic one-size-fits-all approaches that neglect local complexity, heterogeneity and dynamics.

The activities implemented under this theme will support EU environmental legislation and policies targeting a higher level of protection for biodiversity, including the Nature Directives, the Pollinators Initiative, the revised Soil Thematic Strategy, the EU Water Framework Directive, Marine Framework Directive, EU Climate Law and Adaptation Strategy, and deforestation legislation currently being prepared by the Commission. The activities could also speed up actions under the UN Decade on Ecosystem Restoration, as well as the UN Decade of Ocean Science for Sustainable Development.

This will also help to restore EU nature to the largest degree possible, including in ORs and OCTs, and put biodiversity in Europe back on a path of recovery by 2030. In addition to reversing biodiversity loss, this would also lead to increased resilience of ecosystems, and sustained delivery of a wide range of ecosystem services with benefits for society and the economy. R&I could help to scale up these solutions and get them integrated in governance, investment and policy support landscapes. It will also generate knowledge on how restoration (in structure, function and connectivity) can benefit biodiversity and climate change, and bring this information to UN Programs, as well as to the IPBES and IPCC processes.

Finally, activities under this theme (in connection with Cross-cutting Theme B) will help to bring nature back to agricultural land, providing healthy food and diverse diets while maintaining productivity, increase soil fertility and reduce the footprint of food production. Similarly, it will support the restoration and conservation of biodiversity in cities and of green and blue urban ecosystems.

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57. EEA (2020) State of Nature in the EU report - Results from reporting under the nature directives 2013-2018. https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020

58. these activities will include R&I programs tightly linked to actions on the ground, engagement of relevant stakeholders, along with communication and outreach activities

TOPICAL SUB-THEME 1.1: ECOSYSTEM PROTECTION ACROSS LAND AND SEA

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH COMMITS TO:

» protect at least 30% of land and 30% of sea; with 10% of EU land and 10% of EU sea under strict protection, including all remaining EU primary and old-grown forests;

» establish a truly coherent Trans-European Nature Network;

» improve and widen the network of protected areas, define clear conservation objectives and measures, and monitor them appropriately;

» agree on a definition of, and map and monitor, all the EU's remaining primary and old growth forests for their strict protection.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» basic research and actionable knowledge to safeguard species, genetic and ecosystem diversity, considering the different roots, challenges, and consequences associated to different conservation strategies and ethics[59] and recognizing that some taxonomic groups, environments (e.g. freshwater) and dimensions of biodiversity (e.g., genetic and functional diversity, along with evolutionary processes) still need to be better accounted for in conservation and restoration approaches;

» knowledge to support better implementation of landscape approaches on the ground, and thus reconciling agriculture, conservation and other competing land uses;

» knowledge to develop criteria for identifying/designating additional (marine) Protected Areas, (M)PAs, on land and at sea, taking into account trade-offs as well as local complexity and heterogeneity;

» identification of the role and effectiveness of existing types of Protected Areas, Other Effective area-based Conservation Measures (OECMs[60]) and other targeted conservation measures (e.g. for genetic diversity, individual species, or ecological function) in achieving bold conservation targets. Consideration of OECMs provides the opportunity for formal recognition of and support for areas delivering conservation outcomes outside the protected areas);

» assessing the effectiveness of approaches and governance types related to PAs, MPAs, OECMs and other conservation measures (link with Topical sub-theme 2.2.). Governance strategies adopted for nature conservation can indeed vary widely, embracing community management as well as centrally controlled, state-run protected areas and private property regimes. The Convention on Biological Diversity (CBD) encourages devolution of management responsibilities and has drawn attention to the importance of adaptive management (i.e., regular biodiversity monitoring to enable "learning through doing") to complement protected-area governance;

» quantifying the importance of effective habitat connectivity (allowing for species migration and preventing genetic isolation), supporting design of ecological corridors (planning of green and blue infrastructures), and development of criteria for a true Trans-European Nature Network;

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59. Sarrazin F. & Lecomte J. (2016) Evolution in the Anthropocene. Science 351: 922-923.

60. IUCN (2019) Recognising and reporting other effective area-based conservation measures. Protected Area Technical Report Series, Gland, Switzerland; https://doi.org/10.2305/IUCN.CH.2019.PATRS.3.en (https://portals.iucn.org/library/sites/library/files/documents/PATRS-003-En.pdf)

» understanding and promoting the complementary role of Key Biodiversity Areas (KBAs[61], i.e. areas significantly contributing to global persistence of biodiversity) and other mechanisms (e.g. private PAs, OECMs, Indigenous and Community Conserved Areas) in conservation planning and management, and their link to existing protection schemes such as Natura2000;

» developing methodological guidance for using the KBA standard[62] (and hence for identifying KBAs), and for managing, restoring and protecting a KBA;

» how to integrate development issues including human rights and social safeguards issues in biodiversity conservation; how to ensure a broad scale spectrum approach (e.g. through OECMs, Areas of Connectivity Conservation and similar non-traditional conservation tools) (link with Topical sub-theme 2.2.);

» comparative analysis of current Protected Areas management approaches: what does and does not work in terms of conservation under a range of governance types and management categories and with different incentives and interventions. This includes science-based guidance with regard to what "counts" towards any expanded conservation target (link with Topical sub-theme 2.2.). This also includes institutional, cultural and socio-economic contexts and perceptions of biodiversity conservation;

» knowledge on status, trends and ecological role of forests, with a particular focus on remaining primary and old growth forests, as well as other carbon-rich ecosystems such as peatlands, grasslands, wetlands, mangroves and seagrass meadows important for achieving the 10% of EU and 10% of EU sea under strict protection (link with Cross-cutting Theme A). This also includes knowledge on their carbon sequestration potential;

» the conservation community increasingly faces the challenge of climate change. Species distribution areas may change rapidly and in fairly complex ways, and biodiversity in current conserved areas may have to adapt and possibly to be relocated to take into account climate change effect. Further, conservation will be sustainable also on the medium and long term if there is room for ecological and evolutionary processes allowing for adaptation and selection. Through the development of models and scenarios, researchers could provide guidelines to help conservation area managers, policy makers and other stakeholders to anticipate the effect of climate change;

» another major challenge faced by the conservation community is emerging pathogens and invasive species. This requires adapting the way to develop science and practice conservation;

» conservation strategies like assisted colonization, land sharing versus land sparing, and re-wilding or not re-wilding, still require proper knowledge basis and evidence-based assessment. Solutions for cryopreservation and ex-situ methods to preserve genetic resources will also be required.

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61. http://www.keybiodiversityareas.org/home

62. IUCN (2020) Guidelines for using a Global standard for the identification of Key Biodiversity Areas – version 1.1 (https://portals.iucn.org/library/node/49131)

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» the LIFE environment sub-program, funding nature conservation projects in particular in the areas of biodiversity, habitats and species – contributing to the implementation of the EU's directives on birds and habitats, the EU Biodiversity Strategy; and the development, implementation and management of the Natura 2000 network. For example, the LIFE projects could serve as a test bed for models/tools/approaches, whereas knowledge gaps and research needs arising from LIFE projects could be filled by R&I programs implemented by the Partnership;

» the European Environment Agency, and the Joint Research Center (JRC), in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established under Horizon Europe;

» landowners; scientific societies, such as the Society for Conservation Biology; the European Environmental Bureau; the International Union for the Conservation of Nature (IUCN, and related knowledge hubs such as the KBA Technical Working Group); UNEP-WCMC (most notably its World Database on Protected Areas); national, regional and global nature conservation NGOs and their coalitions (such as Seas at Risk, Green 10, etc.); the World Wide Fund for Nature (WWF, and its European priority regions); the Institute for European Environmental Policy; partnership organisations (such a Butterfly Conservation Europe); and other relevant network of experts that could provide bottom-up expertise into policy-linked processes regarding conservation;

» the Blue Economy Partnership regarding the protection of marine ecosystems;

» the future Horizon Missions on healthy oceans, soils and climate adaptation.

TOPICAL SUB-THEME 1.2: ECOSYSTEM RESTORATION ACROSS LAND AND SEA

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH COMMITS TO:

» by 2030, restore significant areas of degraded and carbon-rich ecosystems; ensure that habitats and species show no deterioration in conservation status and trends; and that at least 30% reach favorable conservation status or at least show a positive trend. To this end, the EC will put forward a proposal for legally binding EU nature restoration targets in 2021 which could imply Member States to put in place national nature restoration plans based on a solid evidence base;

» bring nature back in agricultural and forest land, reversing the decline of pollinators, addressing land take and restoring soil, improving forest health and resilience, restoring priority species and habitats in all ecosystems, greening urban and peri-urban areas, reducing pollution (including pesticides and fertilizers), and addressing invasive alien species.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» science-based definition of what constitutes a "favourable ecological condition" and "good ecosystem/biodiversity status" as well as for concepts like "closer-to-nature forest management" introduced by EU Biodiversity Strategy 2030;

» development of indicators to characterize the effectiveness of different restoration methodologies and assess restoration progress over time (including values);

» monitoring the efficacy, efficiency and effectiveness of restoration/previous restoration projects;

» identification of restoration opportunities in different type of ecosystems (marine, terrestrial, freshwater); assessing the restoration potential of degraded ecosystems;

» how can the EU support ecosystem restoration globally, what metrics should be used and how should areas be prioritized for support (link with Topical sub-theme 3.2.);

» study the impact of land degradation on freshwater and coastal ecosystems, including mangroves and seagrass systems; this should include impacts on infectious disease prevalence and transmission,, and climate change;

» study the impact of ecological and biodiversity degradation of marine and freshwater ecosystems from human underwater activities such as mining, dredging, infrastructures, and some fishing methods;

» study the impact of factors beyond land- and seascape degradations, such as pollution, pesticide inputs, sound and light pollution, hunting and fishing;

» understanding the social and environmental consequences of interactions between land and sea degradation, poverty, culture and behaviours, climate change, and the risk of conflict and of migration;

» understanding the importance of ecosystem interaction and biocontrol to help upscale alternative farming techniques under reduced input conditions able to restore and favor agrobiodiversity

–and possibly help tackling climate change, such as agroecology[63] (link with Cross-cutting Theme B); more generally, provide science guidance to a transition towards fully sustainable practices in agriculture (biodiversity-friendly agriculture such as agroecology and organic farming), biodiversity-friendly aquaculture and fisheries, agroforestry (biodiversity-friendly forestry such as closer-to-nature forest management) and soil management (link with Cross-cutting Theme B);

» supporting the design and management of urban and peri-urban green areas, and integration of biodiversity conservation and restoration in urban planning (link with Cross-cutting Theme B);

» analysing the trade-offs and synergies between recreational use and biodiversity status in urban and peri-urban (blue-)green areas;

» analysis of the relative importance of various enabling conditions for avoiding, reducing and reversing ecosystem degradation in different social, cultural, economic and governance contexts;

» impact of connectivity elements on biodiversity restoration;

» investigate from a genomic perspective the success of captive populations when reintroduced in the wild.

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» the LIFE environment sub-program, funding nature restoration projects in particular in the areas of biodiversity, habitats and species – to contribute to the implementation of the EU's directives on birds and habitats, the EU Biodiversity Strategy; and the development, implementation and management of the Natura 2000 network. For example, the LIFE projects could serve as a test bed for models/tools/approaches, whereas knowledge gaps and research needs arising from LIFE projects could be filled by R&I programs implemented by the Partnership;

» the European Environment Agency (EEA), and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;

» the European Environmental Bureau; the IUCN; the Institute for European Environmental Policy; scientific societies, such as the Society for Conservation Biology, the Society for Ecological Restoration; national, regional and global nature conservation NGOs and their coalitions (such as Seas at Risk, Green 10, etc.); Infra Eco Network Europe (IENE); Rewilding Europe; partnership organisations (such a Butterfly Conservation Europe) and other relevant network of experts that could provide bottom-up expertise into policy-linked processes (such as the development of national restoration plans);

» the Partnerships on Agro-ecology Living Labs; Driving Urban Transitions; Water4all; and Blue Economy;

» selected projects funded under the Green Deal Call on 'Restoring biodiversity and ecosystem services' (LC-GD-7-1-2020);

» the future Horizon Missions on healthy oceans and soils.

63. IEEP (2020) What role for R&I in reducing the dependency on pesticides and fertilising products in the EU agriculture (https://ieep.eu/uploads/articles/attachments/f4347295-f7fe-4db8-86de-0a9c89855d0f/IEEP (2020) Role of R&I in reducing pesticides and fertilisers.pdf?v=63770421465)

TOPICAL THEME 2

Actionable knowledge for transformative change to halt biodiversity decline

RATIONALE

Recent flagship reports, such as the IPBES Global Assessment (2019) and the UN's Global Biodiversity Outlook 5 report outline the need for transformative change to halt nature's accelerating decline. There is, however, insufficient knowledge on the potential and challenges arising from transitions focused on biodiversity. Transformative change means shifting away from 'business as usual' through nature conservation and restoration (Topical Theme 1), deployment of Nature-based Solutions (Cross-cutting Theme B) and tackling the drivers of biodiversity loss through an integrated whole-of-society approach, including taking into account the multiple values of nature, environmental-economic accounting, and reinforcing biodiversity governance (the core of Topical Theme 2), also promoting sustainable supply chains and greening trade (Topical Theme 3).

Mainstreaming biodiversity concerns into market transactions, planning and investment decisions is a key approach to make transformative change a reality[64] as it can help to address the underlying causes of biodiversity loss. Many experts and stakeholders, from environmental NGOs to private companies and international organisations, have called for the development of monetary valuation of biodiversity and ecosystem services, so that societies can eventually put a price on what they value so highly but protect so poorly. For example, it helps businesses to evaluate both their impact and dependency on biodiversity; and it can inform the re/insurance industry on implications of biodiversity loss, as well as on opportunities[65]. If they may be part of the solution, such monetary valuations also raise numerous questions in theory and practice. For example, ecosystem services such as mitigation of droughts and floods, climate regulation, coast and soil erosion prevention, and water filtration, as well as services provided in the form of recreational, aesthetic or cultural values vary across national and local boundaries. In the past years, with the increasing importance of natural capital accounting, research on the monetary valuation of living natural resources and also of biodiversity has shown a significant progress, but there is not yet an established framework for valuing biological diversity, nor for prioritization of actions in the value chain. The discussion on monetary and non-monetary valuation is still a hot topic, as also exemplified by ongoing IPBES assessment on diverse conceptualization of values for biodiversity and ecosystem services[66] or 'nature's contributions to people'[67]. There is an urgent need for the research community to collaborate with users to provide trusted impartial guidance to assist in the selection of the right natural capital assessment and valuation methods based upon user requirements. The research community should improve the rigor and standardization of the models and targets used, and thus the resilience (in terms of environmental considerations) of the decisions that result from their application. Valuation is also essential for changing individual consumer behavior, as it can help to highlight the environmental impact of individual choices, and steer consumption towards biodiversity-friendly products.

Another key element to make transformative change to halt biodiversity decline a reality is increasing the effectiveness of governance strategies that successfully address and mitigate impacts of non-sustainable human activities on biodiversity. Such approaches could help the elaboration of policies aiming at the right balance between nature conservation and socio-economic development (including land management, spatial planning and development of economic activities).

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64. King S. et al. (2021) Linking biodiversity into national economic accounting. Env. Sci. Policy 116: 20-29; Convention on Biological Diversity (2020) Global Biodiversity Outlook 5 (https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf)

65. Swiss Re Institute (2017) Biodiversity and Ecosystem Services: A business case for re/insurance (https://www.swissre.com/dam/jcr:a7fe3dca-c4d6-403b-961c-9fab1b2f0455/swiss-re-institute-expertise-publication-biodiversity-and-ecosystem-services.pdf)

66. https://ipbes.net/values-assessment

67. Diaz et al. (2018) Assessing nature's contributions to people. Science 359, 270–272

EXPECTED IMPACTS

R&I on tools, methodologies and frameworks can help to initiate processes, behavior changes and actions which are transforming the way we impact biodiversity. This includes a more holistic valuation of biodiversity and ecosystem services, and adequate governance systems (i.e. being integrative, inclusive, informed and adaptive). It can help to mainstream the use of natural capital accounting in corporate decisions and link natural capital management to commercial success. It will also guide prioritization of actions business organisations in their value chain, and widen effective application of the mitigation hierarchy.

Valuation will also help to assess and monitor the cost-effectiveness and economic viability of Nature-based Solutions (NbS) to meet multiple benefits (environmental, social and economic), and as such it can also contribute to a greater promotion of investments in NbS and to speed up market uptake (link with Cross-cutting Theme B). It can also promote greater engagement of the insurance sector in NbS markets and NbS funding.

R&I under this theme will also help to develop empirically justified governance strategies that improve synergies between nature conservation schemes and the management of human-altered environments, proposing options that offer different benefits for biodiversity and people. It will help to achieve a more coherent spatial planning of sea- and landscapes (link with Topical Theme 1), accounting for ecological, economic and societal considerations in a global (particularly climate) change context. It will help to identify synergies between global and local values and negotiate trade-offs where the two cannot be reconciled, and to distribute the costs and benefits of conservation. As such, it will provide the knowledge base needed to start investing in building biodiversity assets, by making the economic case and linking biodiversity to agendas that matter (e.g. poverty reduction, social justice, security and climate change).

In sum, R&I under – and related to – this theme, will help to identify multiple pathways to achieve the desired outcome, expand action to multiple areas of the economy and society, and identify and realize diverse co-benefits in an efficient manner.

TOPICAL SUB-THEME 2.1: THE MULTIPLE VALUES OF NATURE AND ITS BENEFITS TO PEOPLE

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

» all parts of the economy and society will have to play their role in halting biodiversity loss. Industry and business have an impact on nature, but they also produce the important innovations, partnerships and expertise that can help to address biodiversity loss;

» particular attention should be paid to measures that incentivise and eliminate barriers for the take-up of Nature-based Solutions as these can lead to significant business and employment opportunities in various sectors while enhancing biodiversity;

» rigorous valuation tools are needed to cope with complicated trade-offs in the context of sustainable development initiatives and emerging policies;

» economic and social cost of inaction will be huge.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» development and improvement of methodologies and tools to capture different values of ecosystem services and biodiversity, and to describe different conceptualizations of value and of the relationship between biodiversity and human well-being. Research is still needed to test and compare existing monetary and non-monetary valuation methods. Indicators beyond monetary estimates should be developed as needed and tested, which can give estimates of the value and attitudes (including of local and indigenous communities) towards biodiversity. It is also needed to study valuation methods for Nature-based Solutions that can help assessing their effectiveness in terms of societal, economic and environmental assets. The focus should be on addressing clear gaps, on accounting for ethical issues, on practical use of tools, and areas where real value added could be obtained. For instance, knowledge and assessment of co-benefits is currently still a gap, and costing and valuation of adaptation benefits is largely lacking;

» investigation of human-nature connectedness, extinction of experience (loss of human-nature interactions), and relational values;

» development of rigorous valuation tools in order to cope with complicated trade-offs in the context of sustainable development initiatives and emerging policies;

» a framework for valuing changes in biodiversity, as well as applications for ecological compensation;

» further development of existing practical and implementable natural capital accounting approaches and tools (e.g., that can ultimately be used in companies and banking sector; but also in public sector). This should guide assessments at a landscape or seascape scale, focusing on developing methods to reflect cumulative impacts and variations in environmental quality, social needs and value preferences. Research should explore the impact that the valuation of ecosystem services has on sustainable development, including the design and effectiveness of avoidance/mitigation/compensation mechanisms that could be applied in the case of new developments (also link with Topical Themes 1 and 3);

» development of science-based targets providing a framework and a process for business to align

their individual sustainability actions with globally agreed environmental goals;

» focus on non-monetary valuation of ecosystem services is needed, as it does not yet constitute a formalized methodological field. As such, it often applies coarse and arbitrary indicators and produces results whose accuracy and reliability are hard to judge or difficult to operationalize. To increase the applicability of non-monetary valuation, it is necessary to clarify the boundaries and the terminology of the field, and address considerations with regard to the context-specificity of non-monetary techniques;

» quantification of the environmental impacts of products, or supply and value chains, business models or organisations based on Life Cycle Assessment (LCA) methods;

» quantification of cost of inaction, and thus understanding and seizing the economic risks of deteriorating biodiversity and ecosystem services;

» assessment of the cost-effectiveness and economic viability of Nature-based Solutions to meet multiple benefits (environmental, social and economic) (link to Cross-cutting Theme B). More specifically, decision-makers face an increased number of tools and approaches, and research can help critically compare these tools and help science-based choices by policy-makers for adapted and contextualised legislation and regulation;

» standardised natural capital accounting practices;

» practice- and evidence-based knowledge is needed to guide prioritization of investments, to better assess their impact on the long term, and avoid finance flows potentially harmful to biodiversity. Such knowledge is also needed to stimulate the uptake of innovative financing instruments and mechanisms (such as economic instruments, green bonds, impact investment, blended finance) (link to Topical subtheme 3.1.);

» knowledge base to better link biodiversity to societal agendas related to poverty reduction, social justice, security and climate change;

» develop methodologies to assess legislative impact on biodiversity.

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» the EU Business@Biodiversity Platform, providing a forum to discuss the links between business and biodiversity at EU level and helping to integrate natural capital and biodiversity considerations into business practices;

» UNEP-WCMC, the International Union for the Conservation of Nature, the Institute for European Environmental Policy and individual NGOs helping companies and other societal actors to identify best practice guidance and tools available to support informed business decisions related to biodiversity and natural capital;

» Relevant initiatives and projects such as One Planet Business and Biodiversity (OP2B), Business for Nature, WeValueNature, Natural Capital Coalition, Value Balancing Alliance, Act4Nature, the ALIGN project (Aligning accounting approaches for nature), LIFE Projects like TRANSPARENT, and the Science Based Targets Network,…

» the World Business Council for Sustainable Development, a global, CEO-led organisation of over 200 leading businesses working together to accelerate the transition to a sustainable word;

» Business schools and respective economic institutes;

» NetworkNature, the European multistakeholder platform on NbS;

» the Mapping and Assessment of Ecosystem Services (MAES) and related initiatives such as KIP-INCA/MAIA;

» the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;

» the Partnership on Circular bio-based economy.

TOPICAL SUB-THEME 2.2: GOVERNANCE OF BIODIVERSITY

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

» environmental legislation to tackle the drivers of biodiversity loss relies on proper implementation and enforcement. Over the last 30 years, the EU has put in place a solid legislative framework to protect and restore its natural capital. However, there are still legislation gaps, in particular for agro-, forest- and urban ecosystems, and implementation on the ground is lagging behind. This is having dramatic consequences on biodiversity and comes with a substantial economic cost;

» proper governance approaches will be a prerequisite for successful development and deployment of Nature-based Solutions (Cross-cutting Theme B) at relevant scales and for addressing the needs of different categories of stakeholders;

» biodiversity is relevant to the achievement of the SDGs, including those related to human rights, gender, health, education, and conflict sensitivity.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» analysis of the performance of different governance systems in supporting ecosystem services, resource sustainability and biodiversity. Studies directed at specific regions or natural resources are needed to guide local adaptation strategies, while broader-scale investigations are crucial to plan regional strategies for the use of natural resources. Research should help answer the following questions: Which factors determine governance strategies that foster resilience, sustainable management of biodiversity and an equitable distribution of ecosystem services among social actors? How do local institutional arrangements facilitate awareness raising, social learning and effective management of biodiversity? What are the diversity of interactions between society and ecosystem components and their influence on participation and decision-making? What are the impacts of stakeholder engagement on the efficiency of decision-making for management measures? Especially lessons learnt from failures and less successful cases are relevant in this context;

» study of the interplay between national and international development of laws, and between environmental protection and sustainable use laws and governance systems, to identify obstacles and opportunities for improved implementation;

» analysis of options to better articulate national and European policies, and account for the specificities of biodiversity status and development needs locally. Addressing the relation between global processes (e.g. globalization, climate change, financial controls) and local consequences will

also be needed because local governance, in many cases, will hardly grasp or respond to global pressures/threats (link with Topical Theme 3);

» study of ways to better articulate governance strategies across sectors and policies, and to better integrate needs and knowledge of local actors;

» development of participatory tools and methods to incorporate short-term interests within long-term frameworks, improve our capacity to cope with uncertainties, and integrate local and scientific knowledge on biodiversity for collective and adaptive decision-making;

» support to the development of policies and governance systems aiming at particular balances between nature protection and socio-economic development (including land management and the development of economic activities); this includes analysis of how making Nature-based Solutions sustainable through adequate engagement with, and support by stakeholders and citizens (link with Cross-cutting Theme B). In particular, urbanization creates new challenges for biodiversity conservation and Nature-based Solutions implementation, and for supportive policy frameworks to mainstream biodiversity and Nature-based Solutions in public authorities;

» analysis of which impacts may be possible to offset, and whether proposed offsets are technically feasible as part of the avoidance/mitigation/compensation hierarchy. Ecological knowledge would particularly be needed on implications of offsetting in particular habitats; use of multipliers; timescale required to restore habitats to functioning ecosystems and ensure no net loss; and how to capture spatial mixes of habitats in biodiversity offset design;

» analysis of economic and social instruments to promote effective conservation. Examples include waste-trading schemes, eco-labelling, creation of knowledge networks, and public payment for maintenance of certain ecosystem services, for example through Reduced Emission from Deforestation and environmental Degradation (REDD);

» identification of leverage points, where change in approach/intervention is highly likely to affect the end results strongly;

» evaluation of the effectiveness of different schemes and models for Payment for Ecosystem Services (PES), particularly the trade-offs that arise between policy goals, the integration of multiple values in PES, data on the profiles of PES participants and long-term monitoring of relational and behavioural implications of participation;

» strengthened knowledge base for rights-based approaches in conservation;

» social-ecological systems analysis of the interactions and dynamics associated with biodiversity in social–ecological systems to move beyond analysing and measuring the problem towards the generation of science-based, context-specific pathways towards halting biodiversity loss;

» expand the understanding of governance to also include markets, incentives (and disincentives) and alternative management systems for biodiversity conservation (co-management, community-based management, private management…);

» contributions of behavioral economics in fine-tuning biodiversity conservation interventions.

NEEDS TO STRUCTURE THE KNOWLEDGE LANDSCAPE INCLUDE ENGAGEMENT WITH (NON-EXCLUSIVE LIST):

- the Institute for European Environmental Policy;
- the European Environmental Evaluators Network;
- the European Environmental Bureau;
- the LIFE environment sub-program;
- the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service;
- International Union for the Conservation of Nature;
- relevant European Partnerships, such as the one on Blue Economy for issues related to ocean biodiversity governance;
- relevant Horizon Missions, such as health Oceans, Soils and Climate Adaptation.

TOPICAL THEME 3

Better knowledge to support EU's global action

RATIONALE

The environmental and socioeconomic interactions between distant regions of the world ("telecoupling") are dramatically increasing. In particular, EU impacts biodiversity beyond its borders, mainly due to food consumption, the main hotspots of impacts on biodiversity being meat products/aquaculture/fisheries, the underpinning land and sea use, and climate change[68]. Telecoupling brings about challenges and opportunities to biodiversity conservation that are of a larger magnitude and of a faster pace than ever observed before[69]. Our understanding of the dynamics and leverage points of this telecoupled world is however limited. It is thus important to take stock of what we know and what we still need to know to formulate effective biodiversity conservation policies with telecoupling increasing.

Challenges are presented by the high demands for agricultural and wildlife products by high-income and emerging economies, putting pressure on land protection, management and incentive-based conservation interventions. Opportunities are brought about by the strength of global information flows that can generate strong pressure on multinationals and governments to adopt sustainable practices (e.g. zero-deforestation pledges; certification schemes in key agricultural commodities).

Trade policy can actively support and be part of the ecological transition. It is therefore of paramount importance that the impact of trade agreements on biodiversity is carefully assessed, that biodiversity provisions of existing and new agreements are strengthened, that measures are put in place to avoid or minimize the placing of products associated with terrestrial and marine ecosystem degradation on the EU market, and that biodiversity-friendly imports and value chains are promoted. While EU trade policy puts a great emphasis on trade being a vehicle for sustainable development, available evidence demonstrates that a net positive contribution of the EU trade to sustainable development - going beyond the economic sphere and addressing also environmental and social aspects – is yet to be achieved[70]. Furthermore, research to address illegal and legal wildlife trade should be strengthened, enabling governments to better meet their obligations under the Sustainable Development Goals and international conventions[71], and help avoid the emergence of pandemics[72]. Sustainable, legal and equitable wildlife trade can be a powerful solution for meeting the twin challenges of enhancing rural/coastal livelihoods while conserving biodiversity. For communities empowered by effective and equitable governance systems, the benefits arising from trading wildlife products can catalyse community investments in nature conservation, law enforcement and stewardship of wildlife.

Moreover, as growing experience from around the world suggests, the preservation of biodiversity can only be achieved by taking environmental issues into the heart of economic and financial decision-making. As such, implementing an effective post-2020 global biodiversity framework will require governments and the private sector to scale up biodiversity finance and reduce finance flows that harm biodiversity[73]. It is clear that biodiversity finance must be increased, for example, to improve the coverage and effectiveness of protected area networks, to restore degraded ecosystems, and to mainstream biodiversity concerns across sectors. However, practice- and evidence-based knowledge is needed to guide prioritization of these investments, to better assess

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68. Crenna E. et al. (2019) Biodiversity impacts due to food consumption in Europe. J. Cleaner Prod. 227, 378-391; Marques A. et al. (2019) Increasing impacts of land use on biodiversity and carbon sequestration driven by population and economic growth. Nat. Ecol. Evol. 3, 628–637

69. Carrasco, L.R. et al. (2017). Biodiversity conservation in a telecoupled world. Ecol. Soc. 22(3): 24.

70. IEEP (2020) – IEEP's response to the public consultation on the EU trade policy review (https://ieep.eu/uploads/articles/attachments/078de483-2fe5-462c-9d36-f1ab4d37daad/IEEP's response to the EU Trade Policy Review (Nov 2020).pdf?v=63772477707)

71. https://www.illegalwildlifetrade.net/wp-content/uploads/sites/5/2018/09/Evidence-to-Action_IWT18_Briefing-Note.pdf

72. IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn, Germany. DOI:10.5281/zenodo.4147317

73. OECD (2020) A comprehensive overview of global biodiversity finance

their impact on the long term, and avoid finance flows potentially harmful to biodiversity. Such knowledge is also needed to stimulate the uptake of innovative financing instruments and mechanisms (such as economic instruments, green bonds, impact investment, blended finance). This is especially true for investments in developing countries, often hotspots of biodiversity. Development cooperation providers are increasingly targeting environmental synergies and co-benefits with their aid[74]. Official Development Assistance (ODA) can also be a lever for other sources of biodiversity finance such as environmental fiscal reforms, markets for green products, payment for ecosystem services, biodiversity offsets, and conservation trust funds.

EXPECTED IMPACTS

This theme will deepen the understanding of the relationships between biodiversity loss and production/consumption patterns and thus the economic and social processes underlying environmental problems at a global scale. It will help highlight the root causes of global biodiversity loss, and the role of different sectors in nature conservation through their sectoral activities, as well as of the general public through their lifestyle. It can also help to scale up the suite of policy instruments for biodiversity and get the economic incentives right to ensure biodiversity is better reflected in producer and consumer decision making.

R&I under this theme will also provide guidance to adjust trade agreements, to avoid negative impacts for biodiversity; as well as external policies and programs. As such, it can help to achieve different United Nations (UN) Sustainable Development Goals (SDGs). Successfully achieving SDGs that directly relate to biodiversity conservation (e.g. SDG 15 on Life on Land and SDG 14 on Life Below Water) will contribute to delivering on many other goals, including those related to poverty alleviation, food security/diverse diets, sustainable agriculture, forestry and fisheries, health, economic development, peace and security, and climate change mitigation and adaptation.

Finally, R&I under this theme can help to evaluate the effectiveness of biodiversity finance flows and quantify finance flows to biodiversity at the global scale, and guide prioritization of investments including ODA.

TOPICAL SUB-THEME 3.1: TELECONNECTIONS AND (WILDLIFE) TRADE

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

- while it will be essential that the EU protects and restores biodiversity within its own borders, the vast majority of global biodiversity loss lies in the tropics and the oceans, but is also heavily impacted by EU policies. For example, 10% of global deforestation is directly related to EU trade and consumption, although forest cover is increasing within the EU. The EU therefore has a responsibility to reverse the negative impacts on biodiversity of its trade and consumption patterns, including through increased investments to protect and restore biodiversity in partner countries (cf. link with Topical Theme 1; and Topical subtheme 3.2.);
- trade policy will actively support, and be part of the ecological transition;
- efforts to reduce wildlife trade and consumption can help to prevent possible future diseases and pandemics;

74. https://www.cbd.int/financial/cop12event/oecd-oda.pdf

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» development of models able to identify potential spillover and feedback effects of telecoupling which can be detrimental for biodiversity. Similarly, we need to understand how conservation/restoration interventions can create perverse telecoupled market feedbacks and spillovers;

» analysis of the ways to enhance the traceability of businesses impacts on the environment by developing models that can link remote sensing of land use with companies and purchasing decisions;

» study of how, e.g. voluntary certification schemes, incentives to encourage deforestation-free supply chains, establishing payments for ecosystem services, and certification in key agricultural commodities can be used to obtain positive biodiversity outcomes;

» development of methods for internalizing the biodiversity (and social) costs of unsustainable production practices into commodity prices, and the allocation of such costs to different stages of production, processing and consumption in the life cycle of a product;

» analysis of which biodiversity conservation actions can contribute more cost effectively to change social norms in affluent consumers (including youth) driving demand of wildlife products and agricultural products and thus deforestation, for example, increasing visibility of harmful environmental actions, policy interventions, sanctions;

» study of how to best integrate biodiversity conservation interventions aimed at influencing telecoupling forces with existing on-the-ground interventions at the landscape level. Indeed, even though conservation interventions aimed at influencing telecoupled forces may provide effective ways to attain biodiversity conservation, these are unlikely to yield the desired objectives if they are not combined with on-the-ground conservation/restoration interventions. The integration of multiple scales and approaches, from global to local, will be necessary to materialize the potential incentives and changes generated by telecoupling;

» assessment of the role of EU food consumption in the current biodiversity decline;

» characterization of the ecological footprint of products and activities on the environment, including through life-cycle approaches and natural capital accounting (link with Topical Theme 2);

» analysis of the impact of trade agreements on biodiversity (not only deforestation but also other types of habitat);

» study of the impacts of illegal and legal wildlife trade on wild populations. Limited knowledge leads to interventions based on unsubstantiated assumptions. A better understanding is needed of the role of trade in species declines, in the context of other threatening factors such as land conversion and resource exploitation. Little is known about the factors affecting illegal wildlife trade, how they interact and, crucially, how they shift with policy interventions, technological changes and external drivers;

» analysis of how telecoupling dynamics affect the relation between biodiversity and human rights.

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» researchers and researcher networks from the global South;

» the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;

» the Institute for European Environmental Policy;

» International Union for the Conservation of Nature

» the Wildlife Conservation Society, World Wide Fund for Nature (WWF), and other nature conservation NGOs working at the interplay between biodiversity conservation and development cooperation, with field expertise and experience to identify, formulate, and articulate policy positions on issues such as wildlife trafficking, CITES and integrating wildlife into EU development aid programs;

» EC's Global Cooperation Platform to fight deforestation; Africa-EU Partnership;

» DG DEVCO; DG TRADE;

» ODA agencies and development banks.

TOPICAL SUB-THEME 3.2: INVESTMENTS

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

» natural capital investment offers high economic multipliers and positive climate impact;

» delivering on the post-2020 global biodiversity framework will require greater cooperation with partners, increased support and financing for developing countries, and phasing out of subsidies harmful to biodiversity;

» investing in nature protection and restoration, not only within but also beyond Europe's borders, will be a key element of the economic recovery from the covid-19 crisis.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» development and application of approaches for elucidating the impacts of investments, e.g. from major development banks and aid donors, in low income countries (often hotspots of biodiversity) – making such investments deforestation- and biodiversity-proof; research is needed on how impacts of biodiversity from these investments can be reduced/mitigated;

» identification of the most important areas for biodiversity protection on the planet, including PAs, MPAs and KBAs, and assess risk and financial need to ensure their continued management and protection (link to Topical Theme 1). These areas are of global importance, but often found in low income countries where technical capacity and financial resources are largely lacking. Research programmers and funders (along with aid donors) should, together with relevant researchers and stakeholders (including decision-makers), identify

the most important knowledge gaps (in light of the new targets under the post-2020 global biodiversity framework) and how to tackle these – including through innovative financial mechanisms;

» research into how the EU can support ecosystem protection and restoration globally – what metrics should be used and how should areas be prioritized for support?

» research into how green bonds and other mechanisms are best used to fund conservation projects and how to assess and guarantee their efficacy;

» analysis of investment in climate and other solutions in partner countries, most notably: to what extent biodiversity co-benefits are already happening or being considered; and/or the extent to which there is potential for investments by donors to also result in biodiversity co-benefits;

» research to understand and tackle the persistence of perverse subsidies for unsustainable land and sea use and management in the agriculture and fisheries sectors and through international trade rules.

NEEDS TO STRUCTURE THE KNOWLEDGE LANDSCAPE INCLUDE ENGAGEMENT WITH (NON-EXCLUSIVE LIST):

» the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;

» the Institute for European Environmental Policy;

» the Wildlife Conservation Society, World Wildlife Fund and other nature conservation NGOs working at the interplay between biodiversity conservation and development cooperation, with field expertise and experience to identify, formulate, and articulate policy positions on issues such as wildlife trafficking, CITES and integrating wildlife into EU development aid programs;

» International Union for the Conservation of Nature (IUCN);

» Africa-EU Partnership;

» Banking associations, individual banks, European Central Bank;

» DG DEVCO; DG TRADE;

» ODA agencies and development banks;

» researchers and researcher networks from the global South.

CROSS-CUTTING THEME A

Better knowledge on biodiversity and its dynamics

RATIONALE

Understanding biological diversity in terms of processes by which ecosystems and their components function, be it at ecosystem, species, population or genetic levels, is critical to informing sustainable use of biodiversity and safeguarding it. Biological diversity continually evolves and changes in response to biotic and fluctuations and other environmental pressures, according to assembly rules, evolutionary forces and biotic and abiotic drivers. It is thus necessary to record in time and space (i.e. benchmark) its status and, subsequently, monitor that status in order to identify changes, assess underlying mechanisms, and develop scenarios. In this context, recording both biodiversity status and a range of variables acting as proximal and distal drivers for biodiversity changes (land use and management, climate, exploitation levels, biological invasions, pollutions, governance systems at stake) is of paramount importance.

Literature reviews on biodiversity changes and recent assessments (such as the IPBES assessment for Europe and Central Asia[75] and the FAO State of knowledge of soil biodiversity[76]) are confirming that information on biodiversity trends is biased towards some taxonomic groups and some environments, and that important dimensions of biodiversity (e.g. genetic and functional diversity) still remain to be properly studied. Furthermore, the State of Nature Report 2020[77] identifies a series of knowledge gaps that include the need for a better characterization of the status of many habitats and species, the actual contribution of the Natura 2000 network to conservation status, and more generally the assessment of the health and condition of ecosystems.

In addition, while many efforts have been made to monitor components of European biodiversity, including well established networks to survey populations of common birds and butterflies that deliver on indicators used by policy makers, major knowledge gaps remain for many taxonomic and functional groups. It is also needed to increase the coverage of biodiversity monitoring schemes, to make the best use of traditional and emerging/new methodologies for monitoring, and to harmonize monitoring methods and protocols, variables and databases, as well as indicators across countries and regions. All in all, it is thus needed to establish a pan-European network of harmonized monitoring schemes able to measure and analyse biodiversity changes across Europe, efficiently informing policy makers. This will require biodiversity monitoring at a larger scale than ever before, with higher precision and increased coverage of habitats and environments (including e.g. soil and deep sea), and with data being provided timely, openly and readily understandable. It is also vital that monitoring is consistent over time, allowing detection also of slow and gradual change. Monitoring schemes must therefore be set up with the goal for long-term sustainability in funding and organization. It is also of essence to make particular efforts to support, maintain, digitalize and harmonize existing long-term monitoring schemes which often have unique and valuable datasets. Cost-effectiveness will be paramount for this endeavor, merging classical biodiversity field monitoring with emerging sensor technologies, eDNA, unmanned remote sensing and Artificial Intelligence (AI), as well as participatory citizen science. These efforts can have a strong base in existing national, regional and pan-European infrastructure and monitoring networks and facilities, including research vessels and field stations. Strong liaison between biodiversity monitoring and the monitoring of some ecosystem (dis)services particularly linked to biodiversity, e.g. pollination or health issues, is needed to assess implications of biodiversity changes. Further, strong liaison of biodiversity monitoring and the monitoring of drivers is required to identify threats and possible levers of actions.

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75. IPBES (2018) The regional assessment report on biodiversity and ecosystem services for Europe and Central Asia (https://www.ipbes.net/sites/default/files/spm_2b_eca_digital_0.pdf)

76. FAO (2020) State of knowledge of soil biodiversity – status, challenges and potentialities (http://www.fao.org/3/cb1928en/CB1928EN.pdf)

77. EEA (2020) State of Nature in the EU report - Results from reporting under the nature directives 2013-2018. https://www.eea.europa.eu/publications/state-of-nature-in-the-eu-2020

EXPECTED IMPACTS

Understanding biodiversity change and decline, and addressing their main drivers through data-driven science, integrated multidisciplinary knowledge, new tools, models and scenarios, will inform choice for conservation and restoration policy alternatives and will help assessing the success or failure of conservation policies and regulations (e.g. the EU Habitats Directive's Articles 10 and 18) and revisiting them in face of global change (link to Topical Theme 1). This will have positive impact on European biodiversity per se, as a natural Heritage and as a natural capital underlying human well-being and sustainability.

R&I under this theme will guide regional and international biodiversity discovery initiatives. In addition to knowledge breakthroughs, this will contribute to promote innovation in mainland Europe, ORs and OCTs, through the discovery of new taxa, genes, functions and bioproducts, and by feeding biomimicry approaches. This theme will also help modeling and predicting the effects of global change on biodiversity, and ultimately the cascading socio-economic effects for key sectors like agriculture, health, (agro)forestry and fisheries, either directly through changes in species range and metabolic rate, or indirectly via for example coral bleaching or invasive alien species. It will help anticipate the establishment of pathogens or disease vectors and invasive species, while helping eradication or control of species that have already become established and have demonstrated impacts.

Genotyping and phenotyping wild species can be of interest for a range of sectors linked to cultivated plants, livestock, aquaculture and cultivated micro-organisms. For instance, for many aquacultural and agricultural species, we need characterization of wild individuals for important traits, since the wild relatives act as a valuable reservoir to be introgressed into existing breeding/selection programs/conservation schemes. Similarly, seed production for native plant species and ecotypes is needed, e.g. in the context of deployment of urban Nature-based Solutions and new forestry schemes.

This theme will allow the characterization of the biodiversity footprint of human activities in mainland Europe and ORs and OCTs, building on existing field monitoring and making full use of new approaches and tools like those offered by, e.g. artificial intelligence, remote sensing and eDNA. Biodiversity dynamics will be correlated with environmental changes assessed by earth observation programs and research infrastructures such as Copernicus and relevant infrastructures, and future plausible dynamics will be explored with scenarios. Because we are considering the 2030 horizon and beyond, activities will consider both policy/management-driven science (i.e. according to issues already identified in the policy and management arena) but also more bottom-up science that can propose innovative policy/management options and can address issues not well defined today.

In addition and accordingly to these objectives, an important intended impact of this theme will be the establishment and support to a network of coherent and harmonized monitoring schemes across Europe.

CROSS-CUTTING SUB-THEME A.1. CHARACTERIZING AND UNDERSTANDING BIODIVERSITY STATUS, TRENDS AND DRIVERS

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, THAT COMMITS TO:

» no deterioration in conservation trends and status of all protected habitat and species by 2030[78];

» ensure that at least 30% of species and habitats not currently in favourable status are back in that category by 2030 or show a strong positive trend.

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» better characterization of all biodiversity dimensions and their trends in Europe, accounting for the different organisation levels (functional, genetic and taxonomic) in all compartments (below and aboveground, water). Efforts are particularly needed for the less known organism groups (like microbial or arthropod diversity), environments, compartments (such as soils and deep seas) and dimensions (such as functional diversity and food webs), as well as threatened species, biodiversity-rich areas and hotspots that remain uncharacterized in some parts of mainland Europe and OCTs and ORs, which has major implications for conservation and sustainable management decisions. This is particularly needed to determine what constitutes a "favourable ecological condition" and "good conservation status", better guide conservation strategies and management, and provide new opportunities for innovation. For instance, bio-prospection of new genes, functions and natural substances harboured by aquatic and terrestrial organisms – including microorganisms - can offer great economic opportunities;

» definition of operational metrics, e.g., of genetic, functional and cultural diversity; of evolutionary potential; and of the level of interactions within and between communities and ecosystems (link to Cross-cutting Theme A.2). Regarding cultural diversity, there is a need to explore how local and indigenous knowledge (related to biodiversity and to social and economic costs and benefits of both use and conservation of biodiversity) can contribute to activities that improve the biodiversity status in Europe, and development of participatory tools;

» characterize the threats to all aspect of biodiversity, including functional diversity, in a global change context: this includes the effects of climate change, land use change, overexploitation, pollution, (re)emerging pathogens, and biological invasions. It requires downscaling climate models to adequate levels, for which small regions, islands and archipelagos provide excellent case-studies (e.g Outermost Regions (ORs)/Overseas Countries and Territories (OCTs). A particular attention should be paid to potential impacts of synthetic biology, and of pollutants including new/emerging ones like endocrine disrupters, microplastics and engineered nanoparticules, which have been argued as one pressing issue for the fate of biological diversity in the future. Long-term (possibly transgeneration), cumulative effects on specific taxonomic groups and ecological communities are not yet well understood and deserve further attention. Research identifying phase-shift thresholds of direct and indirect stressors is urgently needed, in particular to guide decisions over limits to extractive activities, such as fishing or logging. Specific threats to animal breeds and plant varieties should also be better understood to guide efficient strategies to conserve and manage genetic resources and their wild relatives;

78. Habitats and species listed under the Birds and Habitat Directives

» knowledge is particularly needed on the effects of multiple stressors and extreme events. This includes understanding the impact of climate change in combination with context-specific drivers on biodiversity and ecosystem services, especially with respect to tipping points and planetary boundaries[79];

» it is also essential to better include social sciences and humanities in the field of biodiversity management to understand the roots of our interactions with non-humans and how social factors (beliefs, value systems, culture, markets, policy, demographics) evolve and determine decision making process and choices for nature conservation and sustainable exploitation (link to Topical Theme 1, and 2);

» role of adaptation in a global change context. Climate, land use, ecosystems, infrastructures, and human societies are all being transformed simultaneously. On-going research has developed a basic understanding of the potential consequences of these concurrent changes, but important uncertainties persist, especially at geographical and time scales relevant to adaptation processes and adoption and use of options for limiting impacts and seizing opportunities. Research should better characterize the sources of flexibility and transformability for species, populations, ecosystems and social-ecological systems, in the face of global change. This should include studies on phenotypic plasticity, evolution, behaviour and migration, reshuffling of biological assemblages, and the dynamics of strategies, knowledge and practices, as well as the relative roles of these different flexibility sources at a range of spatial and temporal scales. Research should also study how indigenous people and local communities in Europe pursue to adapt to environmental changes by exploring holistic solutions able to increase their response capacity and resilience to a broad range of perturbations. Drawing upon different knowledge systems, including indigenous and local knowledge, is appropriate. Stakeholders diversity is therefore a source of resilience, and for which citizen science might be an important asset. Research could be used to propose indicators of adaptation potential. This research is also needed to develop scenarios of biodiversity and a new generation of integrated tools for providing quality-controlled, usable information for near-term decisions with long-term implications;

» knowledge will also have to be reinforced regarding how biodiversity changes imply changes in ecosystem functioning, and ecosystem goods and services and human well-being in different sectors (agriculture, aquaculture & forestry; energy; health, including recreational outdoor activities; etc). This requires analysing how biodiversity relates or contributes to the maintenance and delivery of such services and their resilience to climate change and disturbances. It also requires better knowledge on the cascading effects of direct, indirect and emerging drivers of change, separately and in combination and interaction, on biodiversity, ecosystem function and ecosystem services (at all relevant scales); and provision of methodologies to predict such effects. This includes analysing the importance of breed/variety selection and the utility of locally-adapted genetic resources and species for the delivery of multiple services in agricultural areas and adaptation/mitigation capacity to climate change, invasive alien species and pathogens;

» knowledge on the impacts of pesticides/fertilizers on biodiversity, ecosystem condition and ecosystem services, and guiding criteria and thresholds for the authorization and use of pesticides/fertilizers;

» indicators on the global extent and consequences of biotic homogenization, including genetic homogenization;

79. IPBES (2018) The regional assessment report on biodiversity and ecosystem services for Europe and Central Asia (https://www.ipbes.net/sites/default/files/spm_2b_eca_digital_0.pdf)

» research re-using existing datasets and information from biological collections will be very useful to perform meta-analyses on the dynamics of biodiversity and ecosystem services and their drivers;

» all this science-based knowledge will help integrated impact assessments of (cumulated) direct and indirect stressors on ecosystem processes and services, and assessment of resilience to cumulative pressures;

» comprehensive description of European wildlife genomes, including those of wild relatives of domesticated breeds, to support the preservation of European ecosystems and their biodiversity;

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» the LIFE environment sub-program;

» the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; the Science Service to be established in the context of Horizon Europe;

» the European Environmental Bureau; the International Union for the Conservation of Nature; the Institute for European Environmental Policy; scientific societies, such as the Society for Conservation Biology, the Society for Ecological Restoration; and other relevant network of experts that could provide bottom-up expertise into policy-linked processes;

» European Citizen Science Association (ECSA); the Consortium of European Taxonomic Facilities (CETAF); European Reference Genome Atlas (ERGA);

» relevant long-term monitoring schemes and data repositories in the public and private/NGO domain;

» Major research infrastructures for biodiversity, such as GBIF (through its European and national nodes), LTER-Europe; GEOBON; LifeWatch ERIC; the Analysis and Experimentation on Ecosystems ERIC AnaEE; synthesis research centres for biodiversity located in Europe etc;

» Relevant European Partnerships such as the one on Blue Economy and Water4all;

» Relevant Horizon Missions, such as Healthy Oceans and Soils.

CROSS-CUTTING SUB-THEME A.2. SETTING UP A PAN-EUROPEAN NETWORK OF HARMONIZED MONITORING SCHEMES

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, THAT COMMITS TO:

» no deterioration in conservation trends and status of all protected habitat and species by 2030[80];

» ensure that at least 30% of species and habitats not currently in favourable status are back in that category by 2030 or show a strong positive trend.

MAJOR KNOWLEDGE AND APPROACH NEEDS INCLUDE (NON-EXCLUSIVE LIST):

» harmonization of operationalized protocols and methods used for monitoring biodiversity & ecosystems (including ecosystem services directly linked to biodiversity) across Europe, and harmonization of methods for assessing the state of biodiversity/ecosystems[81];

» harmonization of data format and interoperability for the exchange of data at a transnational level[82];

» improvement of the coverage and representativeness of monitoring schemes. This includes increasing the number of reference sites/points, as well as utilizing and harmonizing existing and new monitoring programs, infrastructures and data repositories in Europe, in a joint effort to calibrate assessments and compare the efficiency of measures. More monitoring efforts should be devoted to lesser-known ecosystems, e.g. soils, calcareous grasslands, Arctic systems, seabeds, etc. This would allow the creation and support of a joint European network of long-term biodiversity monitoring schemes, aiming for an evaluation of trends across land and aquatic habitats, taxa, and functional groups;

» guiding and prioritizing aspects of monitoring schemes to better inform policy makers and other stakeholders. This requires monitoring methods to evaluate the efficiency of public policies and actions on the ground taken by public authorities and other (including private) actors (link to Topical Theme 2, and Cross-cutting Theme B) to protect or restore biodiversity. All dimensions of biodiversity (taxonomic groups, functional groups, ecosystem services directly linked to biodiversity) could be considered when prioritizing. For instance, monitoring efforts could help understanding agriculture, pollution and climate change impacts on pollinators and evaluating the effectiveness of management and adaptation options for securing pollination under future conditions (in relation with the EU pollinator initiative);

» development and deployment of new technologies and approaches (such as eDNA and other molecular biology based approaches, mobile-sensing technology[83], remote sensing through satellites, airborne campaigns and/or drones, acoustics, camera traps, etc.) whose potential still has to be explored by biodiversity research and monitoring activities. This requires the development, transfer and operational use at a transnational level of these new monitoring tools/approaches,

80. Habitats and species listed under the Birds and Habitat Directives

81. Building on the results of the ongoing EuropaBON. Europa Biodiversity Observation Network: integrating data streams to support policy (https://europabon.org/)

82. e.g. Hardisty A.R. et al. (2019) The Bari Manifesto: An interoperability framework for essential biodiversity variables. Ecological Informatics 49 : 22-21

83. Sutherland W.J. et al. (2010) A horizon scan of global conservation issues for 2010. Trends Ecol. Evol. 25: 1-7.

including better use of emerging technologies and algorithms to process this new type of information (for instance artificial intelligence/machine learning/deep-learning). A major goal here is to share knowledge on these new approaches (including need for harmonization, see above) but the use of, e.g., common laboratories and infrastructures. Possible perspectives are to monitor all species-level biodiversity (by DNA barcoding and metagenomics) and genetic diversity within a broad selection of species in Europe; and to relate genetic diversity over given geographical areas to historical land use and cover (this could be done in relation to restoration activities also, link to Topical Theme 1). The deployment of automated and semi-automated high-tech field methods for biodiversity monitoring should be considered, e.g. lidar systems for cover/biomass; automated species identification; and non-destructive invertebrate traps with automatic species recognition;

» promote the contribution of citizens and NGOs to monitoring programs through citizen sciences that have not delivered yet their full potential, both in terms of possible research impact and public engagement and awareness raising about biodiversity among citizens. In addition, the uptake of monitoring information and data by policy makers and other relevant stakeholders (e.g. private sector) should be facilitated;

» definition of common indicators to communicate the results of biodiversity monitoring, taking into consideration – amongst others - ongoing streams of work in the context of the Convention on Biological Diversity, Essential Biodiversity Variables supporting regional and global synthesis, and SEEA EA indicators that can integrate biodiversity values into economic systems. This requires agreement on shared science-based references and common indicators across European countries, in order to compare each country's situation with its neighbours, to feed public policies and to communicate to citizens;

» use of monitoring schemes outputs to better understand and produce biodiversity trends and better understand the relationships between the state of the biodiversity and drivers / pressures. For instance, trend estimation (i.e. data analysis for assessing status and trends) implies mobilizing biostatisticians and applying model-based statistical analyses such as GLMM, GAMM, state-space models like occupancy models, N-mixture models, MRR models, etc. Further, biodiversity monitoring schemes and databases should be articulated with relevant metadata/databases on key drivers, adjusting the biodiversity monitoring schemes accordingly as needed to match biodiversity monitoring data with data for environmental drivers, which makes difficult to raise robust conclusions about the relative role of different drivers. One output could be to advance automated/semi-automated/machine learning systems for analysis of biodiversity data. Another outcome would be the reinforcement of modelling and scenarios built on monitoring outputs;

» use of monitoring data in decision-making (public and private), demonstrating their usefulness e.g. for reporting to Habitats directive, IAS legislation, EU Biodiversity Strategy 2030 and the post-2020 Global Biodiversity Framework (and assessment of impact of National Biodiversity Strategies and Action Plans, i.e. compliance and impact of targets set), ecosystem accounting, private actors, etc.

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

- the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;
- Eurostat which is coordinating ecosystem accounting[84];
- the EuropaBON project;
- Major research infrastructures for biodiversity, such as GBIF (through its European and national nodes), LTER-Europe; GEOBON; LifeWatch ERIC; the Analysis and Experimentation on Ecosystems ERIC AnaEE; synthesis research centres for biodiversity located in Europe etc;
- relevant long-term monitoring schemes in the public and private/NGO domain;
- European Citizen Science Association (ECSA); the Consortium of European Taxonomic Facilities (CETAF); European Reference Genome Atlas (ERGA);
- infrastructures and data management platforms such as GBIF, LTER, Eurofleets, SITES (fieldsites.se), ICP Forests;
- private companies skilled in artificial intelligence applied to biodiversity monitoring;
- Copernicus for the link to land use changes, including historical land covers[85];
- ESA's Biodiversity+ Precursors;
- the European Environmental Bureau; the International Union for the Conservation of Nature; the Institute for European Environmental Policy; organisations such a Butterfly Conservation Europe; scientific societies, such as the Society for Conservation Biology, the Society for Ecological Restoration; and other relevant network of experts that could provide bottom-up expertise into policy-linked processes;
- Relevant European Partnerships such as the one on Blue Economy, Water4all and Agroecology-living labs.

84. https://seea.un.org/ecosystem-accounting
85. https://climate.copernicus.eu/biodiversity

CROSS-CUTTING THEME B

Better knowledge to develop, deploy and assess Nature-based Solutions in a global change context

RATIONALE

Nature-based Solutions are solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse nature and natural features and processes into cities, landscapes and seascapes, through locally, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services[86]. Although different stakeholders view Nature-based Solutions from different perspectives, Nature-based Solutions may have the potential to transform environmental and societal challenges into innovation opportunities, including by turning natural capital into a source for green growth and sustainable development[87] also taking into account concerns of citizens and institutions. Nature-based Solutions are thus seen as sustainable measures that simultaneously meet environmental, societal and economic objectives, which should help maintain and enhance natural capital. Although current models are not yet able to demonstrate the full potential Nature-based Solutions could play an important role in providing incentives for governments, institutions, business and citizens to develop innovative ways to integrate natural capital in policies and planning, and to maintain or increase biodiversity and human well-being. More generally, Nature-based Solutions already constitute a significant component of indicators offered by States following the 2015 Paris climate agreement[88], further underlining the interdependence of the biodiversity and climate change crises.

Despite the benefits of this concept[89], innovation with nature and marketable Nature-based Solutions uptake strongly depend on a solid knowledge base, and engagement of relevant networks and stakeholder groups from policy, business and practice. Much knowledge and practical experience already exists and many Nature-based Solutions are known or have been developed. Yet, they often remain highly under-deployed, and technocratic paradigms and technical solutions are often still being considered as the main options for tackling societal challenges, while adaptive management frameworks of Nature-based Solutions are still lacking. Scientists, policy makers, practitioners and other stakeholders thus need to join forces in order to support the needed systemic transition to a sustainable future allowed by Nature-based Solutions, in which economic, social and environmental needs are in balance.

Documenting and analysing the possible synergies and trade-offs between multiple ecosystem services and between multiple stakeholders' views, and between ecosystem services and biodiversity, will be at the heart of the identification and implementation of Nature-based Solutions. In addition, stakeholders and policy makers must remain aware of the complexities and uncertainties that surround Nature-based Solutions. Assessing the risks associated with a given Nature-based solution should be compulsory and alternative solutions should be envisaged, looking at the potential impacts through time and space, and accounting for future environmental changes. Otherwise, Nature-based Solutions could generate problems instead of solutions (e.g., species introduced for pest control can become invasive, if corresponding controls are lacking).

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86. European Commission definition: https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-Solutions_en; IUCN (2020) Global Standard for Nature-Based Solutions: https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

87. European Commission. (2015). Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Final Report of the Horizon2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities', 70 pp.

88. Laurans Y. et al. (2016) Counting on nature: how government plan to rely on ecosystems for their climate strategies. IDDRI Brief 5/16 April 2016.

89. Eggermont H. et al. (2015) Nature-based Solutions: New Influence for Environmental Management and Research in Europe. GAIA 24: 243-248

Specific work on the different types of Nature-based Solutions[90] particularly important for biodiversity conservation and restoration could be done at the intersection with Topical Theme 1; specific work supporting effective implementation and market uptake could be done at intersection with Topical Theme 2; and upscaling of Nature-based Solutions could be done at intersection with Topical Theme 3.

EXPECTED IMPACTS

This research will support the knowledge base that is required to enable a nature-based transition in Europe, and to better understand the interrelations between biodiversity, health, food, soil, water and climate. It will provide evidence to stakeholders, decision and policy makers, practitioners and public about the multiple benefits, cost-effectiveness and economic viability of Nature-based Solutions to address societal challenges. This will also increase the awareness that economy and nature are not mutually exclusive, in line with the bio-economy view but adopting a complementary, more systemic approach searching for solutions that reinforce the sustainability of European societies and their activity while preserving European biodiversity and natural capital. This will result in better use of available knowledge for informed decision-making, innovative solutions and more effective deployment and market uptake. Finally, R&I will support more robust and integrated Nature-based Solutions for climate change adaptation, and disaster risk reduction at local, regional, national and European level, contributing to the EU Sendai Framework and the EU Strategy on Adaptation To Climate Change[91]. All of this will ultimately promote the European leadership on Nature-based Solutions at the international level.

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

- Nature-based Solutions are a very effective ally in the fight against climate change, health threats and other disasters;
- Nature-based Solutions are at the heart of safeguarding EU and global food security/diverse diets;
- investing in Nature-based Solutions will be critical for Europe's economic recovery from the covid-19 crisis;
- tapping into the full potential of Nature-based Solutions will be crucial to ensure prosperity, sustainability and resilience in the recovery from the pandemic crisis

MAJOR KNOWLEDGE NEEDS INCLUDE (NON-EXCLUSIVE LIST):

- study of what role biodiversity plays or may play in Nature-based Solutions and what aspects of biodiversity that are important. A better understanding of the relationships between biodiversity, ecosystem functions and ecosystem services is required to develop Nature-based Solutions. Here research should focus more than previously on efficiency and resilience properties of systems. Genetic resources and species and community diversity should be explored as a toolbox for

90. Typology according to Eggermont et al. (2015). (id)
Type 1: No or minimal interventions in ecosystems, with the objectives of maintaining or improving the delivery of a range of ES both inside and outside of these conserved ecosystems; Type 2: management approaches that develop sustainable and multifunctional ecosystems and landscapes, with intermediate levels of intervention; Type 3: managing ecosystems in very extensive ways or even creating new ecosystems

91. https://ec.europa.eu/clima/sites/clima/files/adaptation/what/docs/eu_strategy_2021.pdf

Nature-based Solutions, promoting adaptation and sustainability. Indeed genetic diversity and resources offer a great potential to develop and upscale Nature-based Solutions for tackling major societal challenges like climate change regulation and mitigation, and multi-functional and sustainable agriculture and forestry (link with Topical Theme 1). More generally, the mobilization of the research community working on ecological engineering[92] will be key to develop Nature-based Solutions, as natural ecological processes and human interventions are tightly intermingled for many types of Nature-based Solutions;

» analysis of how Nature-based Solutions can offer smart alternatives and complement technical solutions to tackle major challenges like restoration of degraded ecosystems, climate change adaptation and mitigation, disaster risk reduction and disaster preparedness, sustainable urbanisation and agriculture, and more generally improved resilience of ecosystems, communities and societies. In particular, there is an increasing need of knowledge to inform the development of Nature-based Solutions e.g. for enhancing the insurance value of ecosystems, restoring degraded ecosystems and re-naturalizing environments dominated by humans (e.g. cities[93]), increasing carbon storage and sequestration, and improving the sustainability of the food, fiber or energy production systems (link with Topical Theme 1). A possibly even more important issue here is to evaluate the effectiveness of various Nature-based Solutions through science-based assessment of their economic, social and environmental benefits and costs while also addressing the timescale and geographical scale of both costs and benefits. This requires generating knowledge needed to monitor Nature-based Solutions, evaluate their outcome, assess complexities and uncertainties, and guide risk assessments (including the challenges associated to Nature-based Solutions implying the introduction of species and creation of new ecosystems[94]). Genericity of knowledge on Nature-based Solutions should go beyond case studies;

» evaluation of how scaling Nature-based Solutions can support for biodiversity conservation and restoration (link to Topical Theme 1). Ethical issues linked to the increasing capacity of humans to transform 'Nature' should be explored. In addition, research should explore to what extent the reactive "conserve/restore to solve current problems" approaches should be complemented by more proactive "conserve for future adaptation needs" approaches;

» analysis of what are the synergies and trade-offs between social, environmental and economic goals associated with Nature-based Solutions. A systemic approach is required when developing research on Nature-based Solutions, accounting for multiple stakeholders' views and combining the social, economic and environmental perspectives required to prepare a truly sustainable future. This should help identifying Nature-based Solutions that offer maximized synergies, while also analysing the trade-offs inherent to particular Nature-based Solutions;

» search of which approaches and governance systems can reinforce the capacity to innovate with Nature-based Solutions, to develop and deploy them on large scales, and to overcome (some) trade-offs (link to Topical Theme 2). It is important to analyse the drivers, correlates and incentives that could restrict or conversely help the implementation of proposed Nature-based Solutions. This includes the analysis of supportive policies and policy frameworks and of the political and social resistance to change at relevant levels. Consistency of different policies and approaches for integrated spatial planning and efficient Nature-based Solutions deployment (e.g., integrating Nature-based Solutions and green and blue infrastructures) should be assessed. It will also be needed to identify awareness-raising

92. Barot S. et al. (2012) Meeting the relational challenge of ecological engineering within ecological sciences. Ecol. Eng. 45: 13–23

93. European Commission. 2015. Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Final Report of the Horizon2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities', 70 pp.

94. Hobbs R.J. et al. (2014). Managing the whole landscape: historical, hybrid and novel ecosystems. Front. Ecol. Env. 12: 557-564

factors for stakeholders, and explore participatory ways of translating and sharing lessons learned on Nature-based Solutions including on principles and standards. However, there is a need for improving the tools in order to achieve "sustainability-by-design". The same tools can also be used to evaluate the efficiency and the efficacy of Nature-based Solutions;

» knowledge base for the development, deployment and assessment of Nature-based Solutions, including in an urban and peri-urban context helping to realize the full potential of the proposed Urban Greening Plans to be developed by all cities across Europe;

» research on the potential use of Nature-based Solutions to tackle the emergence of zoonotic diseases, and on their benefits for public health. This requires to better understand the relationship between biodiversity and infectious disease, and how ecosystem change and biodiversity loss may affect the ecology of disease / vector organisms and the dynamics of pathogen-host interactions. Tropical and subtropical Outermost Regions (ORs) and Overseas Countries and Territories (OCTs) are particularly relevant locations for studying the impact of climate change on such interactions, since their weather conditions mimic to some extent those expected in mainland Europe following climate change. Research could focus on ecosystem health risks, ecosystem health services, or both and should go a step further than already done: it should help to further identify at-risk areas and develop recommendations for mitigating the risks;

» better knowledge on the causes of zoonotic and epidemic outbreaks, and design of science-based, systemic solutions to prevent such outbreaks. Research can also support the set-up of early-warning systems for epidemics outbreaks, looking for example at sentinel species combined with modelling approaches (link Cross-cutting theme A);

» knowledge to operationalize the EU commitment to enhance its support to global efforts to apply the One Health approach. How support should best be prioritized and deployed would benefit from further study and analysis of the existing science.

ADDRESSING THESE KNOWLEDGE NEEDS INCLUDES ENGAGING WITH (NON-EXCLUSIVE LIST):

» the International Union for the Conservation of Nature;

» the Partnerships on Agroecology Living Labs; Driving Urban Transitions; Water4all; and Blue Economy;

» the European Environment Agency, and the Joint Research Center, in particular through the European Knowledge Center for Biodiversity; and the Science Service to be established in the context of Horizon Europe;

» NetworkNature, the European multistakeholder platform on Nature-based Solutions;

» the LIFE program;

» the Institute for European Environmental Policy; Alter-NET; scientific societies, such as the Society for Conservation Biology, the Society for Ecological Restoration; and other relevant network of experts that could provide bottom-up expertise into policy-linked processes; ICLEI (network of local governments) as well as individual local governments; …

» relevant Horizon Missions, such as Health Oceans, Soils, Cities and Climate Adaptation.

4. ENABLING APPROACHES


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The Biodiversity Partnership will seek to address a broad range of biodiversity issues, most of which are deeply entwined with the actions and decisions of societal and policy actors. To this end, activities for Topical and Cross-cutting Themes will be implemented in a collaborative and inclusive way by promoting stakeholders at all relevant levels and in all relevant sectors (first enabling approach), and continuously communicating and increasing accessibility to knowledge and data (second enabling approach).

While we fully recognize the role of nature/environmental education for the sustainable and equitable use of biodiversity and its conservation, and for better connecting (new) audiences to nature, educational activities sensu stricto do not fall within the scope of the European Biodiversity Partnership. Still, we will ensure that our activities produce knowledge products and other outcomes that can be taken up in educational programmes, as well as capacity building activities that will reinforce the capacity of young scientists and policy experts in evidence-based policymaking. Moreover, environmental education will be reinforced through the Partnership's investment in citizen science (see 4.1.).

4.1. STAKEHOLDER ENGAGEMENT

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

» There should be an 'integrated' and 'whole-of-society' approach with participation of all stakeholders throughout the implementation of the EU Biodiversity Strategy to 2030;

» Enabling transformative change requires co-responsibility and co-ownership by all relevant actors in meeting the EU's biodiversity commitments;

» Tackling biodiversity loss and restoring ecosystems will require significant public and private investments and engagement at national and European level;

» Industry and business have an impact on nature, but they also produce important innovations, partnerships and expertise that can help address biodiversity loss;

» Biodiversity considerations need to be better integrated into public and business decision-making at all levels;

» Education for environmental sustainability, and youth engagement are important for making societal transformation a reality.

RATIONALE:

As biodiversity issues are often at the cross-roads of numerous political and socio-economic interests, questions raised require to account for sectors such as environment but also agriculture and fisheries, mining, energy, health etc. and promote a cross-sectoral approach towards the conservation and sustainable management and use of biodiversity, which involves a broad range of stakeholders. In order to be effective and inclusive, research and innovation on biodiversity needs recognize

the limitations of the linear model of research[95] to take into account multiple criteria and stakeholder perspectives. Increasing research impact thus requires an innovative approach to research programming and implementation. While it is understood that good evidence-based advice can only stem from good science it is equally true that advice will only be useful if it addresses issues that are perceived as relevant to society and its different stakeholders. This Partnership will build upon the successful approach developed and used in the context of BiodivERsA (see Figure 8) promoting the (co-)generation of relevant knowledge and continuous engagement of stakeholders from policy, practice and business, and allowing scientists to act as honest brokers of policy and/or management alternatives (sensu Pielke[96]). It will address both formulation and channeling of stakeholders' knowledge and needs into research and innovation, as well as facilitate the uptake of research outputs into outputs of societal or market value (i.e. quick translation of new findings into concrete recommendations for environmental policies and for promoting innovation).

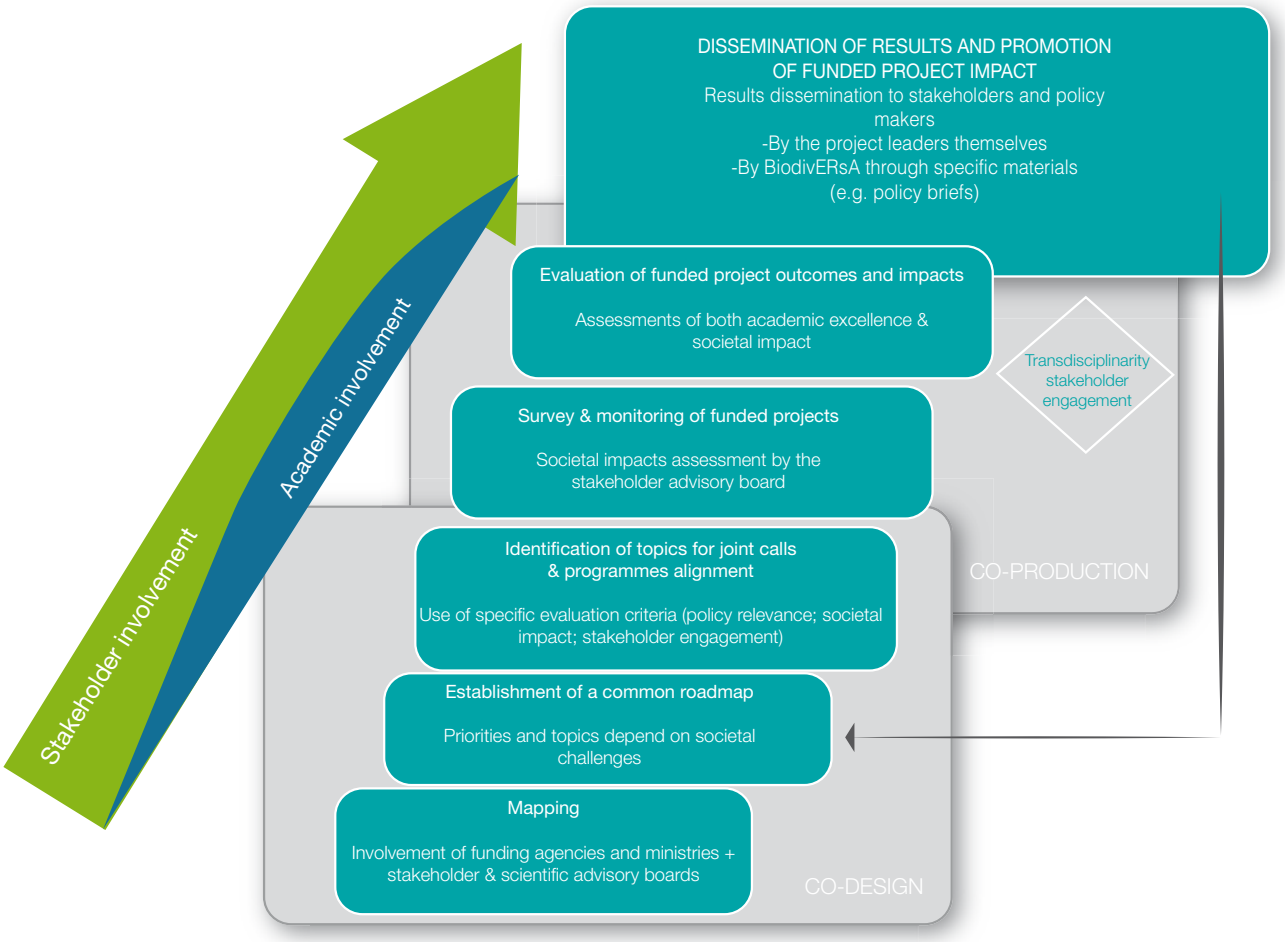

Figure 8: Approach and methodology used to engage stakeholders and promote the science-policy and science-society dialogue in BiodivERsA throughout the research development process. While academic excellence is a major criterion for evaluating research supported by BiodivERsA (and by extension by the Biodiversity Partnership), innovative approaches are used (from co-design of programs to promotion of research results) to increase the societal impact of the funded research. *Figure after Mauser et al. 2013*[97].

95. Barot S. et al. (2015) Evolving away from the linear model of research. Trends Ecol. Evol. 30: 368-370 ; Durham E. et al. (2014) The BiodivERsA Stakeholder Engagement Handbook. BiodivERsA, Paris, 108 pp. (https://www.biodiversa.org/705/download)

96. Pielke R.A. (2007) The honest broker. Making sense of science in policy and politics. Cambridge University Press. 188 pp.

97. Mauser W. et al. (2013) Transdisciplinary global change research: the co-creation of knowledge for sustainability. Current Opinion in Environmental Sustainability 5: 420-431

MAIN APPROACHES AND EXPECTED IMPACTS:

The enabling approach for stakeholder engagement is transversal to all Topical and Cross-cutting themes, and is expected to allow systemic co-design, co-development and co-implementation of research and innovation on biodiversity and Nature-based Solutions. Specific approaches and related expected impacts are fivefold:

1. **Stakeholder mapping**, in an inclusive, purposeful and systematic manner;

2. **Stakeholder engagement throughout the whole process of the Partnership** (cf. figure 8), related to co-design and implementation of coherent and impactful activities on relevant topics at the science-policy or science-society interface on biodiversity. Key steps in this process will be:

   » regular consultations with the Advisory Board and Enlarged Stakeholder Board of the Biodiversity Partnership[98] allowing two-way exchanges and mobilization of a large number of stakeholders;

   » one-on-one collaborations with well-established and emerging initiatives throughout the lifetime of the Partnership, and tailored to specific activities and objectives. Some of these initiatives/organisations will play a specific role in further reaching out to our target audiences, and stakeholders more widely (e.g. Science Mechanism, the European Knowledge Center on Biodiversity, NetworkNature, Oppla, and many others);

   » develop narratives and contents on the importance of stakeholder engagement in the context of the partnership to demonstrate impact reached in this context (link to communication activities).

3. **Reinforced capacity of R&I actors regarding the engagement of stakeholders in their research activities**, including engagement of policy stakeholders, of citizens and of businesses, notably through development and promotion of guidance tools[99] and training. This is fundamental since the R&I individuals and teams are important entities that need to engage stakeholders (biodiversity researchers can have very good links with individual local and national stakeholders), whereas the European Partnership per se will help capacity building for engagement with European and international stakeholders that researchers often strive to engage. Activities will be primarily aimed at research audience, but some capacity development for non-academic audiences could be considered (e.g. when establishing knowledge hubs). It will also include the roll out of summer schools (for example in collaboration with ALTER-Net).

4. **Further increase the societal relevance of the research and awareness of citizens of the biodiversity crisis**, by advancing participation of civil society and co-production of knowledge with citizens, including through citizen science[100]. This includes:

   » capacities to engage with citizens, including the young generation, through the further development of capacities of the research community to engage in citizen science (further development of guidance, tools, and other resources e.g. around trainings and citizen science plans

98. The Partnership Advisory Board will be composed of a few scientists and non-academic stakeholders. The Enlarged Stakeholder Board will include six colleges: (i) Habitat, species and nature conservation; (ii) economic and industrial activities; (iii) relations with the public; (iv) wild and domestic genetic resources; (v) European Policymakers and members of the European Parliament; (vi) boundary organisations.

99. such as: Durham E. et al. (2014) The BiodivERsA Stakeholder Engagement Handbook. BiodivERsA, Paris, 108 pp. (https://www.biodiversa.org/705/download); Lemaitre F. et al. (2018) BiodivERsA guide on policy relevance of research and on effective science/ policy interfacing in research proposals. BiodivERsA report, 80 pp.(https://www.biodiversa.org/1563/download)

100. See Goudeseune L. et al. (2020) BiodivERsA Citizen Science Toolkit for Biodiversity Scientists. BiodivERsA Report, 44 pp. (https://www.biodiversa.org/1810/download)

development, legal frameworks for citizen science, etc.);

» further advancing the understanding and evaluation of citizen science in R&I programs (e.g. further showcasing and exemplifying successful citizen science approaches, showcasing added-value of citizen science for both better science and increased awareness of citizens, analyzing and promoting capacities to support citizen science in R&I programs, providing guidance for applicants/evaluation, etc.);

» Promote longer term engagement of citizens in science, through potential collaborations with key long-term citizen science initiatives (e.g. European Citizen Science Association, Earthwatch, iNaturalist,…) and (co-development of) activities around education and citizen science.

5. **Build longer-term research collaborations with policy, practice and business stakeholders**. Based on previous experience, three-year projects are often too short to adequately engage with stakeholders and obtain tangible outcomes, in particular regarding the use of research results. The Partnership will therefore take care to shape the R&I programs and implement them in a way to ensure longer-term engagement and more profound, lasting impacts.

4.2. COMMUNICATION, OUTREACH AND OPEN SCIENCE

LINK WITH THE EU BIODIVERSITY STRATEGY 2030, WHICH ACKNOWLEDGES THAT:

» the fight against biodiversity loss must be underpinned by sound science. Investing in research, innovation and knowledge exchange will be key to gathering the best data and developing the best Nature-based Solutions;

» efforts are needed to make the bridge between science, policy and practice by promoting best practices through traditional and innovative communication channels.

RATIONALE:

In order to reach its main objectives, demonstrate its impact and increase its visibility, the Partnership will have to properly communicate, disseminate and exploit the results coming from its different activities and its funded projects. Dedicated activities will be needed to highlight the positive results and impacts of the Biodiversity Partnership for a broad range of actors, including researchers and research institutes, practitioners, companies, policy makers, media and citizens. This will contribute to explain in an accessible way the processes and relationships that take place between the natural environment and society/economy, which is needed for a change in public awareness and dissemination of knowledge about the importance of biodiversity.

Moreover, when researchers openly share knowledge and data as early as possible in the research process with all relevant actors, it helps increasing trust in science, rapid knowledge brokerage and adequate uptake on the ground. Reproducible science and shared data are increasingly paid attention to, which is promoted and supported by emerging initatives such as the European Open Science Cloud (EOSC) and the European Commissions Open Research Europe (open access publishing platform). Many datasets are now automatically standardised and freely available through open/FAIR[101] data aggregators such as Global Biodiversity Information Facility (GBIF), the Ocean Biodiversity Information System (OBIS) or other repositories. Dedicated efforts by the Biodiversity Partnership will be needed to further contribute to open and timely access to biodiversity knowledge and data meeting the FAIR principles, and thus making sure one can search, find, read and reuse the most important outcomes.

MAIN ACTIVITIES:

A range of activities will be implemented to facilitate access to knowledge and data produced by the European Biodiversity Partnership, and to demonstrate and make visible its added-value and impacts. Activities will be mutually reinforcing, and include:

1. Development of a Partnership e-platform/website that will act as a 'lighthouse' for the European Research Area on biodiversity, explaining the role of R&I across Europe for the protection, restoration and sustainable management of biodiversity and for the development of Nature-based Solutions. The e-platform will also include a centralized knowledge hub making data and

101. Findability, accessibility, interoperability and reusability – by Wilkinson M.D. et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3: 160018.

information gathered across the funded projects Findable, Accessible, Interoperable and Reusable. More specifically, this will ensure that Partnership-related data are discoverable through catalogues and search engines, accessible as open data, made available with minimum time delay, understandable in a way that allows researchers of different disciplines to use them, and where useful made understandable to non-scientists, as well as manageable and protected from loss for future use in sustainable, trustworthy repositories. The e-platform will also allow for quick calculation of key performance indicators related to communication and outreach, and impacts of the Biodiversity Partnership more generally.

2. Development of communication material and the organisation of (participatory) communication events with the media or other relevant actors to highlighting major outputs and impact of the Partnership and its funded projects and contribute to raising awareness. Specific focus will be placed on the development of success stories, including the production of videos building on a 'Prize for Excellence and Impact'[102] demonstrating concrete impacts of biodiversity R&I tackling concrete societal needs across Europe. Failures could also be used to highlight the challenges that need to be tackled. Other communication tools include the production of policy briefs and other policy-relevant products based on the outputs of the Partnership-funded projects. ;

3. Development of co-designed approaches between researchers and professionals from the media, including social media, for two-way capacity building. This will include the organization of workshops and capacity building events gathering scientists and environmental journalists.

EXPECTED IMPACTS:

Communication, outreach and open science will be key to demonstrate the impact of the Partnership as a whole, and of its specific activities. In particular, the following impacts are identified:

» increased visibility of the European Biodiversity Partnership, its activities and outputs both from individual funded projects and from cross-cutting efforts;

» recognized added value of the partnership for the research community and for relevant non-academic stakeholders, including policy-makers;

» increased uptake of results of the partnership-funded projects and increased brokerage and transfer of science-based knowledge towards relevant stakeholders;

» better informed policy development and implementation, with provision of a science-based support to policy evaluation and policy design;

» increased awareness raising on biodiversity related issues, and science-based solutions offered by biodiversity to tackle different societal challenges;

» generation of FAIR data and knowledge products, and contribution to the European Open Science Cloud (EOSC);

» reinforced capacity of biodiversity researchers to communicate towards the general public, including through social media and in relation with environmental journalists.

102. http://www.biodiversa.org/1550; and the BiodivERsA Youtube channel: https://www.youtube.com/channel/UCw0po9oiUGUEE-j04VApuWTw

ENGAGEMENT WITH OTHER INITIATIVES:

The Biodiversity Partnership will engage with existing initiatives/organisations to increase the visibility of the Partnership activities, organize events with high impact potential and to increase the uptake of the knowledge derived from the projects funded by the European Partnership. These include, amongst others:

- The Oppla platform, to increase the visibility and uptake of results derived in particular from projects on Nature-based Solutions;
- Private companies, such as Pensoft, for the design and roll-out of the centralized knowledge hub for Partnership-funded projects on the e-platform;
- The European Federation of Journalists, the European Union of Science Journalists' Associations, and environment-oriented journalist networks;
- Relevant EU and national services and institutions…

5. STEPS TOWARDS ANNUAL IMPLEMENTATION PLANS

5.1. ANNUAL IMPLEMENTATION PLANS

Following European Commission rules, the Partnership will establish annual implementation plans, including:

» multi-annual 'Flagship Programs' addressing a particular biodiversity issue, aligned with the themes identified in the SRIA, and gathering a specific portfolio of activities relevant to the issue addressed (see 5.2.; Figure 10). The aim is to launch typically 1 to 2 Flagship Programs per year, which could run over several years. The launch of Flagship Programs will allow sufficient focus of the Partnership's activities to make a difference for a number of issues, ensuring efficiency and impact. In particular, a priority group of possible flagship programs has been identified, which could be implemented in the coming years (see below). Each year, the priority group will be updated (note that being part of the priority group on previous year is not a prerequisite for a flagship program to be selected and implemented on a given year, nor is it a guarantee that the topic will be selected for implementation at a later stage).

» a set of 'baseline/core joint activities' including preparation of enlargement to new members as needed, dialogue and as relevant engagement with other initiatives, communication and outreach concerning the Partnership, administration and financial duties, etc.

These annual plans (that do include the launching of multi-annual programmes to ensure a longer term vision) will build on the major research gaps and needs identified above but also considering the innovative potential of bottom-up research; this includes both needs for more research and for structuration of the field through, e.g., biodiversity monitoring activities and their link to R&I, links to research infrastructures, etc.

The formation of these annual plans will be achieved through input from the Partnership members, the Partnership Advisory Board, the relevant EC services –in particular in the context of Horizon Europe- and collaborations and dialogues with relevant stakeholders (in particular through the Enlarged Stakeholder Board).

When developing the annual implementation plans, a specific mechanism will be employed to identify and select the topics for the Flagship Programs, some of which might include a calls for research proposals, to be implemented each year by the Partnership (Fig. 9).

Collected suggestions will be further elaborated and prioritized by Partnership members and in consultation with the European Commission, and the resulting priority groups of topics for future Flagship Programs and calls will be reflected in annual implementation plans.

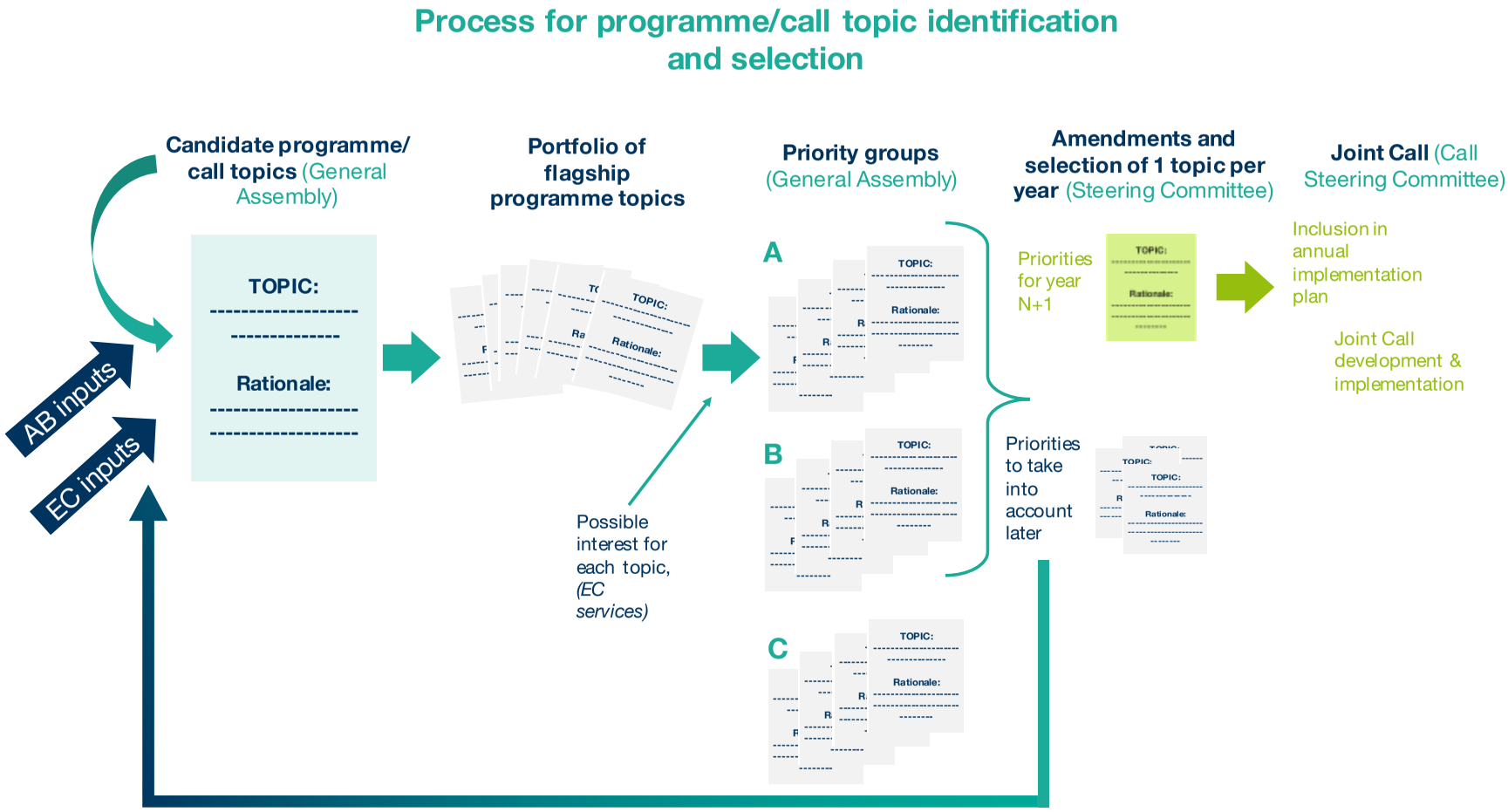

Figure 9: Process used each year to propose and select the topics of the flagship programs and joint calls to be included in the annual implementation plans.

5.2. BROAD TYPES OF ACTIVITIES IMPLEMENTED THROUGH FLAGSHIP PROGRAMS

Flagship programs will aim at implementing a holistic set of activities, which may relate to mapping and foresight, joint call(s) for support to research, reinforcement of the link between research and biodiversity monitoring/infrastructure, capacity building activities, stakeholder engagement and science society/policy interfacing. At this stage the following elements (non exclusive) have been identified (Fig. 10):

» activities to promote and support R&I programs and projects across the European Research Area – a flagship program may include for instance activities around the launching of a joint call to fund transnational R&I projects; implementing mobility schemes (e.g. young scientists, science-business); promoting the reuse of existing data/data sets and synthesis research; alignment with EU open science policies; reinforcing the link between R&I projects and research infrastructure, observatories and demonstrators; promoting citizen science;

» activities to build capacity of R&I actors and increase the impact of R&I programs and projects, including science-based policy support – a flagship program may include for instance capacity building activities to help scientists on specific skillsets (e.g. data management plans, communication to specific audience); reinforcing and harmonizing biodiversity monitoring schemes across Europe, and their capacity to support policy; or activities to increase the brokerage and transfer of science-based knowledge, science-based support to policy evaluation and policy design, collaborative learning and awareness raising;

» activities to reinforce the excellence, visibility and impact of European R&I at the international level – a flagship program may for instance include activities towards the promotion of international collaboration pro-active engagement in IPBES activities; or support to the implementation of the post-2020 global biodiversity framework.

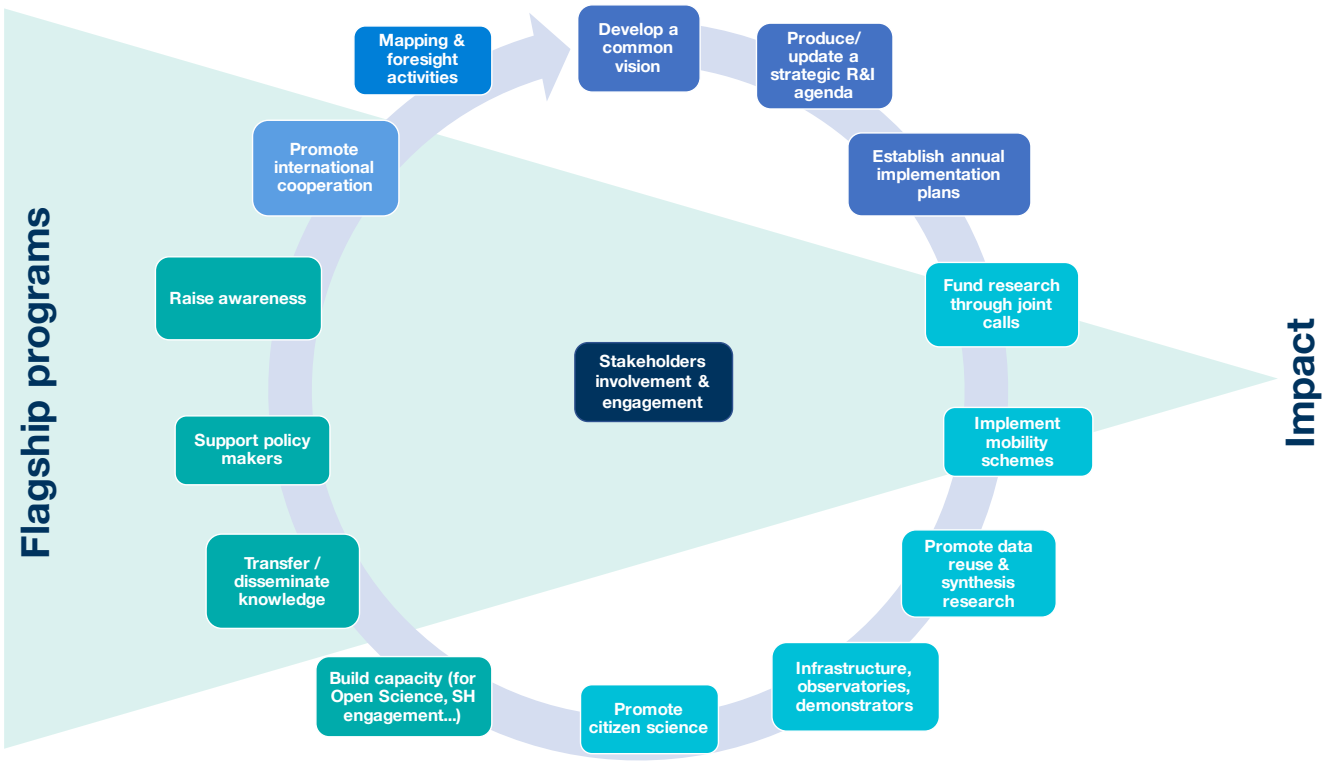

Figure 10: A flagship program will implement in a holistic manner, a range of activities to effectively support achieving its objectives.

6. COMPLEMENTARITY BETWEEN THE PARTNERSHIP AND OTHER PROGRAMS AND INITIATIVES WITHIN HORIZON EUROPE

This section details the complementarities with other programs and initiatives part of Horizon Europe, i.e. beyond the stakeholders and collaborators identified above. The collaboration will be further adapted as the Horizon Europe Work Programme is being rolled out.

6.1. COMPLEMENTARITY WITH GREEN DEAL CALLS, HORIZON EUROPE CALLS & MISSIONS

The recent Horizon 2020 call on 'Restoring biodiversity and ecosystem services' in support of the European Green Deal[103] supports actions demonstrating and promoting systemic solutions on restoring biodiversity and ecosystem services and 'deliver tangible benefits for biodiversity and climate change mitigation and adaptation, upscaling restoration challenges, restoration potential of degraded ecosystems. Important factors will be the significance of research for supporting EU policy needs and contribution to the international biodiversity agenda, technical and economic feasibility of proposed actions, EU added value, co-benefits across multiple sectors, and synergies/complementarity with the European Biodiversity Partnership and other relevant Horizon Europe Missions and Partnerships. This call is especially relevant for Topical Subtheme 1.2. on Ecosystem restoration across land and sea.

The Work Programs of Horizon Europe Cluster 6, 'Food, Bioeconomy, Natural Resources, Agriculture and Environment' contain several complementary initiatives relative to the Partnership. The document is grouped into 7 Destinations, out of which 5 have more or less clear biodiversity components, notably on biodiversity as integral part of primary production, and as part of Nature-based Solutions in support of food production, soil health and nutrient retention, but also topics on understanding biodiversity decline, trends and status; biodiversity protection and restoration; valuation of ecosystem services and natural capital; the links with zoonoses and other diseases; and the linkages between trade, extractive land use, social practices climate change and biodiversity.

Especially Destination 1 on 'Biodiversity and Ecosystem Services' in the draft Horizon Europe Work Program 2021-2022 is directly relevant to the European Biodiversity Partnership. It includes several calls for Research and Innovation Actions (RIAs – at least 14) with whom the Partnership could foresee joint/clustering activities such as networking of project scientists, policy products (including policy briefs) and capacity building activities (e.g. in the context of MEAs, IPBES/IPCC). There are also several relevant Coordination Support Actions (CSAs – at least 6) including the Science Service, and the successor of NetworkNature with whom the Partnership intends to build a strong link to ensure timely inputs into the Knowledge Center on Biodiversity, as well as a connection with Innovation Actions (IAs), respectively. A continuous dialogue between the European Commission and the European Partnership on biodiversity will ensure that the Horizon Europe 'main' work programmes and the Partnership work plans do not overlap unintentionally and are complementary.

Furthermore, several of the Missions[104] recently created as part of Horizon Europe are relevant from a biodiversity perspective, in particular "Soil Health and Food[105]", "Adaptation to Climate Change including Society Transformation"[106], and "Healthy Oceans, seas coastal and inland waters"[107] and "Climate

103. https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1669
104. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe_en
105. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/soil-health-and-food_en
106. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/adaptation-climate-change-including-societal-transformation_en
107. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/healthy-oceans-seas-coastal-and-inland-waters_en

Neutral and Smart Cities"[108]. For these Missions there is clear scope for joint efforts and exchange of information to identify synergies and avoid duplications. All four mention biodiversity aspects in various parts. The Biodiversity Partnership will on a regular basis identify Partnership activities as well as funded projects and their outcomes which would be relevant for the Horizon Europe Missions, and will provide the Missions with such material. A reasonable aim is to also have annual meetings with the Mission boards, to discuss the involvement of the Partnership in the areas covered by each of these Missions and in the context of relevant initiatives and Horizon Europe actions.

Last but not least, the European Biodiversity Partnership will be key in the development and implementation of the EU's **long-term strategic research agenda for biodiversity**.

108. https://ec.europa.eu/info/horizon-europe/missions-horizon-europe/climate-neutral-and-smart-cities_en

6.2. COLLABORATION WITH OTHER EUROPEAN PARTNERSHIPS

The European Biodiversity Partnership will ensure coherence and collaboration with other Partnerships, by establishing a forum relevant for the biodiversity, ecosystem services and Nature-based Solutions agenda (Fig. 11). This forum could be supported for instance by a dedicated CSA and would ensure coordination and maximized synergies between the European Biodiversity Partnership and other initiatives from Horizon Europe. At this stage, discussions have been engaged with precursors of four of these partnerships considered as candidates for collaboration (Table 1). Partnerships can cover similar topics, but approached from a different (complementary) angle.

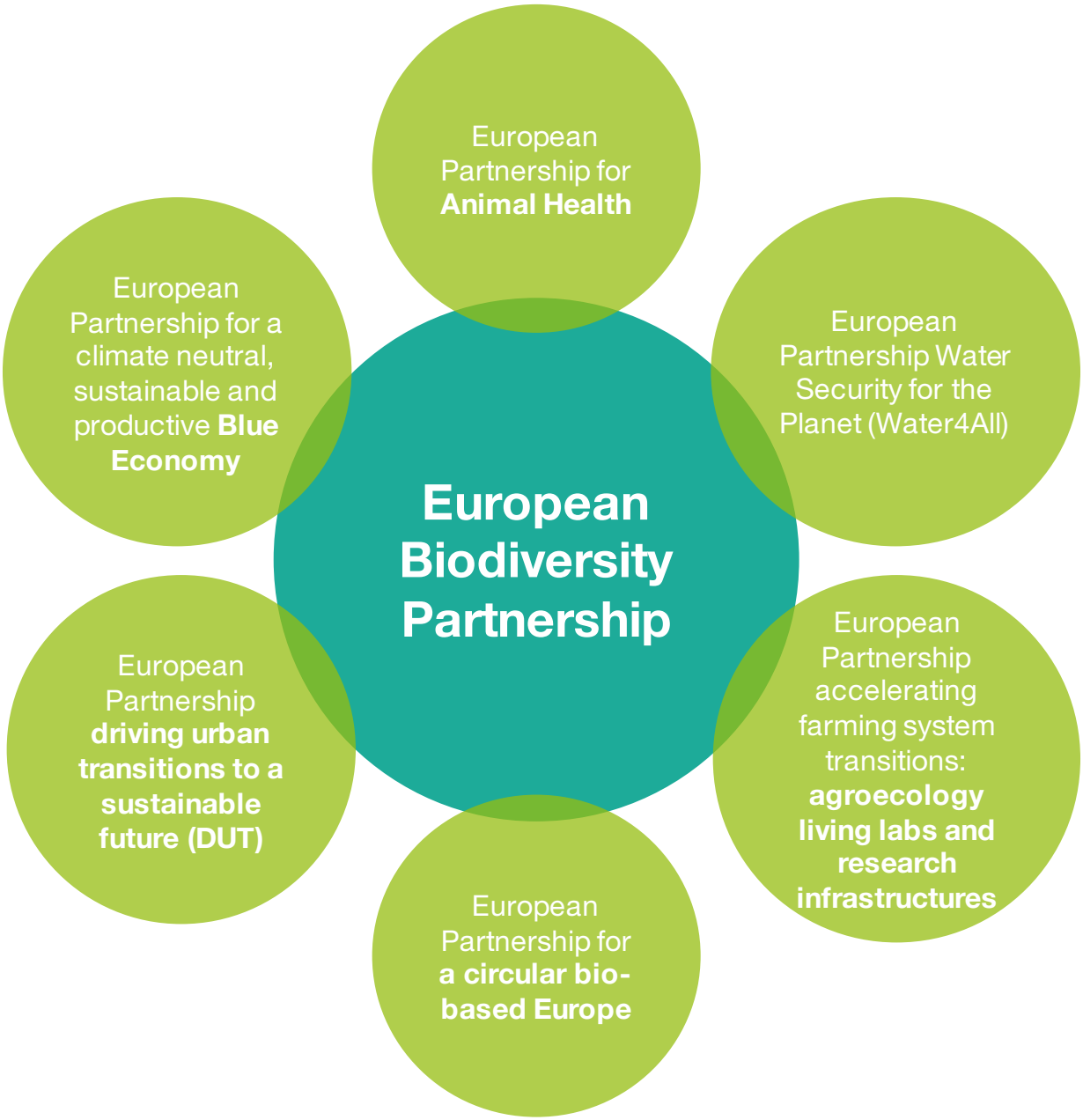

Figure 11: Main other European partnerships that would be invited to participate to the biodiversity forum set up by the Biodiversity Partnership, in close link to the EC, for promoting coherence and synergies in the biodiversity, ecosystem services and Nature-based Solutions domain. Additional Partnerships could be invited as needed.

Table 1: List of the main candidate partnerships identified for collaboration, and possible types of collaborative activities

Candidate Partnerships	Types of activities	Expected results
Accelerating farm system transitions: **Agro-ecology living labs** and research infrastructures *	(i) organise regular meetings for early exchanges on workplan development and identification of synergies, (ii) mobilize the results from the Partnership on biodiversity to inform the Agroecology Living Labs, and (iii) implement joint activities as appropriate	» R&I programs/projects relevant to inform agroecology approaches » relevant knowledge channelled to Living Labs through factsheet, briefs and other means
Circular bio-based economy**	(i) explorative meetings to identify common interests between the two Partnerships and possible synergies, and (ii) implement joint activities as appropriate	» R&I activities to boost sustainable management and use of biodiversity by key private sectors » Joint actions to mainstream biodiversity in business
Water4All: **Water security** for the planet	(i) organise workshop(s) to evaluate issues of common interest between the two Partnerships and identify possible synergies, and (ii) implement joint activities as appropriate	» R&I programs/projects on freshwater biodiversity and associated ecosystem services (possible clustering approach) » Joint activities regarding the restoration of aquatic biodiversity and ecosystems
A climate neutral, sustainable and productive **Blue Economy**	(i) workshop(s) to identify shared priorities regarding marine biodiversity protection, sustainable management of marine (socio)ecosystems, and marine/coastal Nature-based Solutions; (ii) implement joint activities as appropriate	» R&I programs/projects informing management of marine (socio)ecosystems for stopping marine biodiversity loss (e.g. MPA schemes in relation with fisheries and other anthropogenic activities) » Development and assessment of Nature-based Solutions like coastal ecosystem conservation to avoid coastal erosion
Sustainable, smart and inclusive cities and communities - **Driving urban transitions** to a sustainable future	(i) early, organise workshop(s) to evaluate issues of common interest regarding urban biodiversity and Nature-based Solutions, (ii) organise regular meetings to exchange on workplan development and identify possible synergies, and (iii) implement joint activities as appropriate	» A strategic plan, co-designed by both Partnerships, identifying common priorities and explaining how to address these » Possibly implementation of a joint R&I program on urban biodiversity and Nature-based Solutions, and increased urban blue and green infrastructure
Animal Health**	(i) explorative meetings to identify common interests between the two Partnerships and possible synergies, and (ii) implement joint activities as appropriate	» Possibly R&I activities to Onehealth/Ecohealth approaches

* discussions will be engaged with the *Agroecology* CSA funded to prepare this collaboration

**discussions to be engaged

7. EVALUATION AND MONITORING OF THE IMPACT OF THE PARTNERSHIP

The progress of the European Biodiversity Partnership towards reaching the main objectives presented in this SRIA will be surveyed by the Partnership members and the European Commission, along with the Partnership Advisory Board, in order to implement the necessary adjustments to our activities and to the SRIA itself. The Biodiversity Partnership outputs, as well as short and longer-term impacts, will be assessed using a set of indicators, distinguishing:

» Indicators of the performance of the Biodiversity Partnership (table 2a), i.e. indicators to assess the following: Partnership objectives ➔ Partnership Activities ➔ Partnership outcomes

» Indicators of performance of research projects funded through the Partnership (table 2b), i.e. indicators to assess the following: Objectives of funded projects ➔ Projects' Activities ➔ Outcomes of the funded projects

Table 2a: **Possible indicators of the performance of the European Biodiversity Partnership**. Note that quantitative indicators, although needed, will not be sufficient, and the Partnership members will also focus on how results are used (e.g. the number of policy briefs may be less relevant than their impact).

Core objectives	Activities	Expected outcomes	Examples of quantitative indicators
Support transnational biodiversity research projects able to generate major academic breakthroughs and actionable knowledge to tackle the biodiversity crisis	Foresight and identification of research priorities	The Biodiversity Partnership identifies emerging research priorities and accounts for these in its activities	- Number of topics jointly identified and used to support knowledge generation - Reports analysing research agendas and synthesising common priorities between the members of the Partnership and the European Commission
	Funding in support of research projects through the launch of annual joint calls	The Biodiversity Partnership offers a recurrent and well-identified funding source for pan-European research on biodiversity and Nature-based Solutions	- Number of joint calls launched - Volume of funding (from national/local organisations and from European Commission) - Number of projects and research teams funded, and level of trans-national collaboration

Core objectives	Activities	Expected outcomes	Examples of quantitative indicators
Reduce the fragmentation in knowledge generation for the development of efficient approaches for biodiversity conservation and Nature-based Solutions across Europe	Enlarge geographical scope of cooperation	The Biodiversity Partnership reaches a critical mass to coordinate research on biodiversity and Nature-based Solutions across Europe	- Number of countries and regions involved in the consortium (incl geographical coverage) - Number of participating countries and regions participating in joint calls
	Share information and practices among the Biodiversity Partnership partners, build capacities	Information and best practices are known and accessible to the Biodiversity Partnership members	- Number of projects/ programmes/countries in the Biodiversity Partnership database - Number of countries involved in Staff Exchange Schemes - Shared rules and procedures, incl. evaluation procedures and joint monitoring of projects
	Analyse the research landscape	The Biodiversity Partnership provides a complete view on European biodiversity and Nature-based Solutions research	- Number of reports analysing the research landscape (e.g. funding, type of research, collaborations, research infrastructures) - Portal for improved access to European and national research infrastructures
	Share priorities in support of joint programming	The Biodiversity Partnership partners share a common vision on how to support biodiversity and Nature-based Solutions research	- Common SRIA produced and updated as needed - Annual implementation plan produced
	Align research programmes within and between countries	Biodiversity Partnership identifies successful approaches to the alignment of national programmes	- Number of national mirror groups set up - Number of programme alignment implemented
	Engage with other European initiatives working on or with links to biodiversity and Nature-based Solutions	Research programming and funding on biodiversity and Nature-based Solutions is addressed in a concerted manner with relevant European initiatives	- Number and range of initiatives engaged (other European Partnerships, missions, EC-funded projects, EKC, etc.)
	Ensure the sustainability of the structure	The Biodiversity Partnership is supported by Member States, Associated and Candidate Countries, and the European Commission,	- Number of partners and prospective support beyond the 7 year period of the Partnership

Core objectives	Activities	Expected outcomes	Examples of quantitative indicators
Contribute to the 3 topical themes of this SRIA	Implement a number of flagship programs (some of them including joint calls) conceived as game changers regarding these objectives, each built by merging a range activities in a systemic manner	- Basic knowledge is generated which helps to improve our overall understanding of biodiversity and which insights can be a starting point and / or support the generation of actionable knowledge - Actionable knowledge is generated which helps to better protect and restore biodiversity across land and sea - Actionable knowledge is generated which contributes to transformative change regarding human-nature relationships - Actionable knowledge is generated which supports EU's global action for biodiversity	- Major scientific breakthroughs in basic and actionable research
Contribute to the 2 cross-cutting themes of this SRIA	Implement a number of flagship programs (some of them including joint calls) conceived as game changers regarding these objectives, each built by merging a range activities in a systemic manner	- Better knowledge generated to characterize and understand biodiversity status, trends and drivers - Harmonization of data and new methods and techniques to improve monitoring - Reinforced capacity of European countries and the EU to monitor biodiversity - Basic and actionable knowledge to develop, deploy and assess Nature-based Solutions at scale	- Major scientific breakthroughs in basic and actionable knowledge - Establishment (coverage, resources, etc.) of a pan-European network of harmonized monitoring schemes for biodiversity, which efficiently informs decision makers

Core objectives	Activities	Expected outcomes	Examples of quantitative indicators
Promote an efficient liaison between science & society/policy, and research & innovation, throughout the whole research process	Implementation of the stakeholder model of research (transdisciplinary approach)	The Biodiversity Partnership promotes the engagement of relevant stakeholders throughout the whole research process, and provides the knowledge basis needed by stakeholders (including citizens)	- Number of consultations of the Advisory Board, and inputs taken up by the Biodiversity Partnership - Number and range of stakeholders consulted on the SRIA and implementation plans - Number and range of stakeholders involved in foresight and dissemination workshops - Number and range of stakeholders involved in the selection of research projects - Number of tools developed to support stakeholder engagement - Assessment of the uptake of funded projects' outputs by stakeholders
	Develop links between research and innovation/ business	The Biodiversity Partnership supports the transfer of knowledge and technologies developed in research projects it funds to support a sustainable economic development in Europe	- Number of implemented science-business mobility schemes - Number of workshops dedicated to science-business interactions and knowledge transfer - Number of technology transfers in funded projects; number of businesses spinning off/ benefiting from funded project results
	Promote the efficiency of science-society and research-innovation liaison	The Biodiversity Partnership contributes to the transfer of knowledge and technology from research to society	- Number of policy briefs produced and disseminated - Number of stakeholder and policy-maker intended outputs by research projects
Increase the profile of European science and innovation on biodiversity and Nature based Solutions	Build capacities	Early career researchers have opportunities to build European collaborations and link their research to societal needs	- Number of early career researcher schemes implemented - Number of early career research positions in funded projects
	Develop links with international initiatives promoting and programming research	European research is coordinated and valued in international research frameworks through the Biodiversity Partnership	- Number of joint activities (including joint calls) implemented with non European countries
	Develop links with the IPBES	Research supported by the Biodiversity Partnership is coordinated with and feeds into international research efforts on biodiversity and Nature-based Solutions	- Volume of knowledge obtained by Biodiversity Partnership-funded projects synthesised and feeding into IPBES assessments

Table 2b: Possible indicators of the performance of projects funded by the Biodiversity Partnership. Note that quantitative indicators will not be sufficient, and the Partnership members will also focus on how projects' results are used. In particular success stories could be identified and publicized.

Type of outcome	Expected outcomes	Examples of quantitative indicators
Academic	Generation of new knowledge advancing scientific concepts and knowledge	» Number of publications in peer-reviewed journals » Number of publications in top-generalist journals » Range and average impact factors » Number and range of publications in non-natural sciences peer reviewed journals » Number of PhD theses resulting from the projects
	Exploit complementarities between different national research communities	» Average number of countries involved in projects » Number of joint publications across countries, and countries involved » Funded projects publishing in both natural and social sciences/humanities journals
Societal	Engagement of non-academic stakeholders and building of evidence-based decision-making	» Number of projects using tools to support stakeholder engagement (e.g. Stakeholder Engagement Handbook) » Number and range of stakeholders involved in projects » Timing of engagement of stakeholders, roles, and methods used » Intensity and sustainability of stakeholders' engagement in projects » Number of publications in practitionersand applied sciences journals » Number of products intended for stakeholders
	Transfer of knowledge and technology to non-academic stakeholders	» Number of projects engaging with businesses and knowledge and technology transfer organisations » Number of patents and spin-off companies resulting from projects » Number of policy briefs/options produced by projects » Number of other stakeholder-intended products produced » Number of stakeholder-intended workshops and meetings organised » Number of interventions in non-academic events » Number of translations in local languages (of guiding documents, policy briefs etc;)

These indicators will be reported to the members of the Biodiversity Partnership, the Advisory Board, and the European Commission on a regular basis in the form of a balanced scorecard. Tables 2a and 2b present the envisaged quantitative indicators. In addition, the Partnership members will implement a number of qualitative indicators. An example of qualitative indicators to assess the performance of the Partnership could result from the survey of national and European perceptions of the impact of the Partnership, targeting relevant players or from the survey of perceptions of national research communities on the type of research promoted by the Partnership. An example of qualitative indicators for funded projects could result from the survey perceptions of stakeholders on their involvement in projects or the uptake and use of knowledge and technology developed under BiodivERsA projects. Another type of qualitative indicators encompassing both types of indicators and planned part of the enabling approach 'Communication and Outreach' (section 4.2) is the production of "impact case-studies" relating successful examples of how the Partnership's activities or funded research project's outcomes have resulted into wider socio-economic or political impacts and changes.

Year after year, the implementation plans will take the evaluation results into account to ensure the Partnership will reach its goals and intended outcomes. In particular, it is needed to evaluate the impact of stakeholder engagement, promoted by the European Biodiversity Partnership, assessing at the same time the academic quality of the research as well as the environmental and socio-economic research impacts. An innovative methodology has already been developed by BiodivERsA to jointly assess the academic and non-academic outcomes of funded research projects[109]. Accordingly, efforts will be made to test and future-proof the 'expected' socio-economic impact expectations set out in the present strategic agenda, by monitoring –as far as possible- user uptake of research outcomes by relevant stakeholders.

109. Lemaitre F. & Le Roux X. (2021) Analysis of the outputs of BiodivERsA funded projects: Projects completed over 2014-2018. BiodivERsA report, 55 pp.

ANNEX I – FLAGSHIP PROGRAMMES TO BE INITIATED IN FIRST TWO YEARS OF THE PARTNERSHIP

The Partnership will launch a series of Flagship Programmes to implement a holistic set of activities around a given topic, including mapping and foresight, joint calls for research, reinforcement of the link between research & monitoring, capacity building activities, stakeholder engagement and science society/policy interfacing.

The following Flagship Programmes will be initiated in the first year of the Partnership:

Supporting biodiversity and ecosystem protection across land and sea

Key objectives:

» Contribute to coherent protection, spatial planning and integrative management of sea- and landscapes, accounting for ecological, economic and social considerations in a global change context;

» Better knowledge to safeguard species, genetic and ecosystem diversity, recognizing all dimensions of biodiversity;

» Delivering actionable knowledge for scaling-up conservation approaches (both area-based and species-based), acknowledging local complexity, heterogeneity and dynamics;

Better transnational monitoring of biodiversity to better characterize, understand and report on biodiversity dynamics and trends

Key objectives:

» To establish a transnational network of biodiversity monitoring schemes for a few selected biodiversity facets, including harmonizing protocols, data format and interoperability, and methods;

» To develop and deploy new technologies and approaches, to promote citizen science, and to increase the use of biodiversity monitoring data by R&I.

» To better inform policy makers and other stakeholders;

The following Flagship Programmes will be initiated in the second year of the Partnership:

Better knowledge to develop, deploy and assess Nature-based Solutions

Key objectives:

» Better knowledge to develop, deploy and assess nature-based solutions, including in urban settings and taking into account the context of climate change;

» Increased awareness of the cost-effectiveness and sustainability of nature-based solutions;

» Promoting ecological transition in various contexts and at different scales.

Supporting societal transformation for the sustainable use and management of biodiversity

Key objectives:

» Promote societal transformation to mainstream biodiversity considerations across sectors and policies, and better valuation of biodiversity and its benefits to people;

» Promote social–ecological systems analysis of complex interactions to identify effective pathways to the conservation of biodiversity;

» Develop empirically justified governance strategies that improve synergies between nature conservation schemes and management of human-altered environments.

ANNEX II - INSTITUTIONAL CONTRIBUTIONS RECEIVED VIA PUBLIC CONSULTATIONS DURING THE DEVELOPMENT OF THIS PARTNERSHIP

Between the 4/01/2021 and the 1/02/2021, BiodivERsA and the European Commission's DG R&I and DG ENV launched an open consultation to review the draft Strategic Research and Innovation Agenda of the Horizon Europe Partnership on Biodiversity.

The objective was to collect feedback on the draft SRIA from a wide range of academic and non-academic stakeholder organisations. A total of 108 contributions were received, of which 69 corresponded to institutional feedback retained for the statistical analysis and comments synthesis (Fig 12). The responding organisations were mainly from EU countries (Fig 13), the list of the 69 organisations that contributed to the open consultation is available in the Table 3.

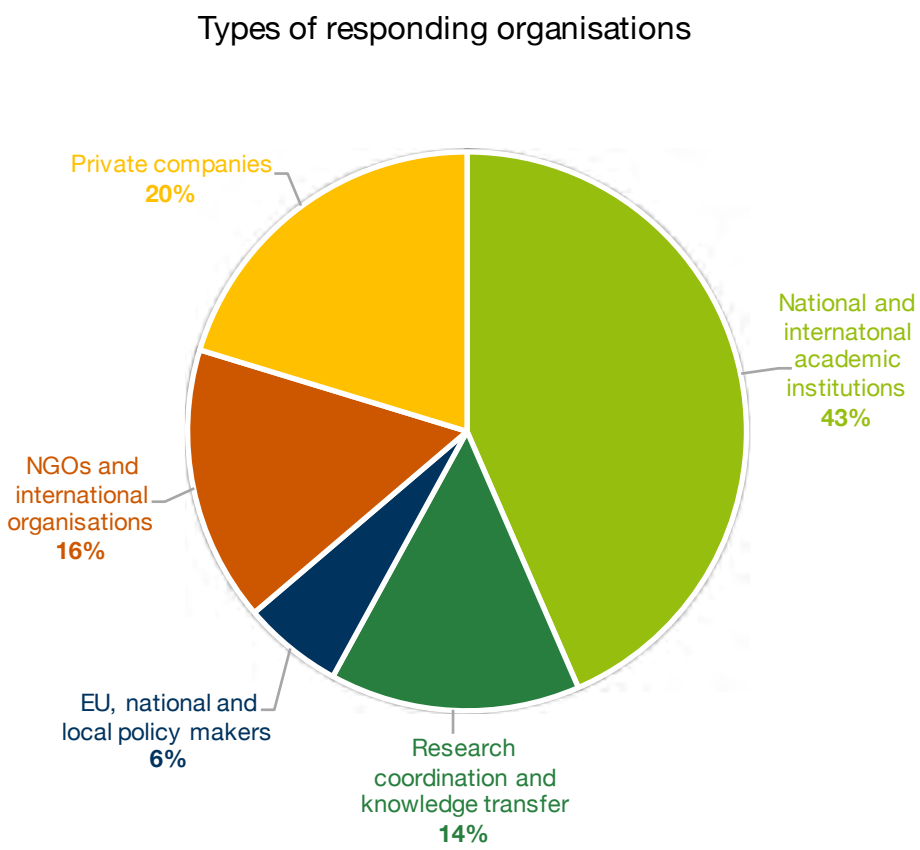

Fig 12: Types of responding organisations to the open consultation on the Horizon Europe Partnership on Biodiversity

Fig 13: Geographical origin of the responding organisations to the open consultation on the Horizon Europe Partnership on Biodiversity

Table 3: List of organisations which contributed to the open consultation on the Horizon Europe Partnership on Biodiversity

Name of organisation	Country of organisation	Type of organisation
EFARO	European Organisation	European research organisation/ initiative
SCAR-Fish	European Organisation	European research organisation/ initiative
Water4All candidate Partnership	European Organisation	European research organisation/ initiative
CETAF, Consortium of European Taxonomic Facilities	European Organisation	European research organisation/ initiative
European Reference Genome Atlas (ERGA)	European Organisation	European research organisation/ initiative
Naturalis Biodiversity Center / DiSSCo	European Organisation	European research organisation/ initiative
Foundation 3D Environmental Change	International Organisation	International research organisation/initiative
Marine Biodiversity Observation Network Secretariat (MBON)	International Organisation	International research organisation/initiative
“Austrian Biodiversity Council” (Österreichischer Biodiversitätsrat)	Austria	Knowledge and Technology Transfer Organisation
EATiP - European Aquaculture Technology & Innovation Platform	European Organisation	Knowledge and Technology Transfer Organisation
Butterfly Conservation Europe	European Organisation	NGO for nature protection
WCS EU	European Organisation	NGO for nature protection

Name of organisation	Country of organisation	Type of organisation
Association for Farmers Rights Defense, AFRD	Georgia	NGO for nature protection
The Nature Conservancy	International Organisation	NGO for nature protection
IUCN	International Organisation	NGO for nature protection
A.N.G.E.V.	Italy	NGO for nature protection
Excelsior Association for the Promotion of Natural and Cultural Heritage of Banat and Crisana	Romania	NGO for nature protection
IFLA EUROPE	European Organisation	Other NGO
Eurocities	European Organisation	Other NGO
Alternet: Europe's Science Policy Interface for Biodiversity and Ecosystem Services	European Organisation	Other NGO
Hope 4 Ebola Orphans Foundation	Netherlands	Other NGO
DG ENV Business@Biodiversity Platform	European Organisation	Policy maker, advisor and public authority (European)
City of Gothenburg, department of environmental governance	Sweden	Policy maker, advisor and public authority (local)
Nature Conservation Agency of the Czech Republic	Czech Republic	Policy maker, advisor and public authority (national)
Swedish Agency for Marine and Water Management	Sweden	Policy maker, advisor and public authority (national)
INTEGRA Group	Czech Republic	Private company (multinational/ group)
Primafrio	Spain	Private company (multinational/ group)
Ramboll Sweden AB	Sweden	Private company (multinational/ group)
Pensoft Publishers Ltd.	Bulgaria	Private company (SME)
Biocon Ltd.	Czech Republic	Private company (SME)
HI-Iberia Ingenieria y Proyectos SL	Spain	Private company (SME)
AGROAMB PRODALT, SL	Spain	Private company (SME)
INNAT	Spain	Private company (SME)
PATATAS FRITAS DE SORIA GARIJO BAIGORRI, S.L.	Spain	Private company (SME)
SingularGreen	Spain	Private company (SME)
EURECAT - CENTRE TECNOLÒGIC DE CATALUNYA	Spain	Private Research Institute
Growing Media Europe AISBL	European Organisation	Private sector network/cluster
Royal Dutch Association of Gardeners and Landscapers	Netherlands	Private sector network/cluster
ADVID- Associação para o Desenvolvimento da Viticultura Duriense	Portugal	Private sector network/cluster
La Unió de Llauradors	Spain	Private sector network/cluster
Naturhistorisches Museum Wien	Austria	Public Research Institute
Meise Botanic Garden	Belgium	Public Research Institute

Name of organisation	Country of organisation	Type of organisation
VITO NV	Belgium	Public Research Institute
INBO (Research Institute Nature and Forest Flanders)	Belgium	Public Research Institute
Natural Resources Institute Finland (Luke)	Finland	Public Research Institute
IRD	France	Public Research Institute
CNRS (Centre National de la Recherche Scientifique)	France	Public Research Institute
Muséum national d'histoire naturelle	France	Public Research Institute
INRAE	France	Public Research Institute
Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB)	Germany	Public Research Institute
Leibniz Research Alliance "Biodiversity" (LVB)	Germany	Public Research Institute
ISOE – Institute for Social-Ecological Research	Germany	Public Research Institute
Hungarian Natural History Museum	Hungary	Public Research Institute
Centre for Ecological Research	Hungary	Public Research Institute
Universidade de Coimbra	Portugal	Public Research Institute
NEIKER - Basque Institute for Agricultural Research and Development	Spain	Public Research Institute
Instituto Español de Oceanografía	Spain	Public Research Institute
CREAF	Spain	Public Research Institute
European Plant Science Organisation, EPSO	European Organisation	Scientific society or association
Hungarian Ecological Society	Hungary	Scientific society or association
Ornis italica	Italy	Scientific society or association
Vrije Universiteit Brussel (VUB)	Belgium	University / Higher Education
Institute of Tropical Medicine, Antwerp	Belgium	University / Higher Education
Szechenyi Istvan University	Hungary	University / Higher Education
Università di Roma Tor Vergata	Italy	University / Higher Education
Latvia University of Life Sciences and Technologies	Latvia	University / Higher Education
Wrocław University of Environmental and Life Sciences	Poland	University / Higher Education
Adam Mickiewicz University	Poland	University / Higher Education
Uppsala University	Sweden	University / Higher Education

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