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A knowledge synthesis and analysis of biodiversity conservation measures highlighting the relevant EU policies, projects and initiatives

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Abstract

The urgency of saving European biodiversity can hardly be overemphasised. This report presents an overview of the measures needed for biodiversity conservation, as well the main EU actions addressing them. It provides a synthesis and preliminary analysis of the state of current knowledge on conservation issues, and of the wide range of EU policy domains, projects and initiatives that address or influence biodiversity conservation, directly as well as indirectly. The primary aim is to improve public awareness on biodiversity conservation and the wide range of conservation actions needed, highlighting the EU's efforts in this regard. In addition, this synthesis might help identify potential gaps and actions that need reinforcement.

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1 Introduction

This study is part of a series initiated by the Knowledge Centre for Biodiversity (KCBD) to raise awareness on the importance of embedding biodiversity concerns in all relevant policy domains. The series describes the efforts of the European Union in this direction, key to effecting transformative change and a green transition. The content targets a wide audience, prioritising accessibility for the layperson as well as interest for specialists, policymakers and researchers. All the reports in the series follow a common structure, which was originally designed for the thematic pages of the website of the KCBD ([1]), and determined collectively with other knowledge centres as part of the Knowledge for Policy (K4P) initiative of the European Commission. This report highlights the importance of conservation measures: measures to protect and restore biodiversity, as well as to mitigate the drivers of biodiversity loss. It discusses the relevant action taken by the EU in the form of policies, projects and initiatives.

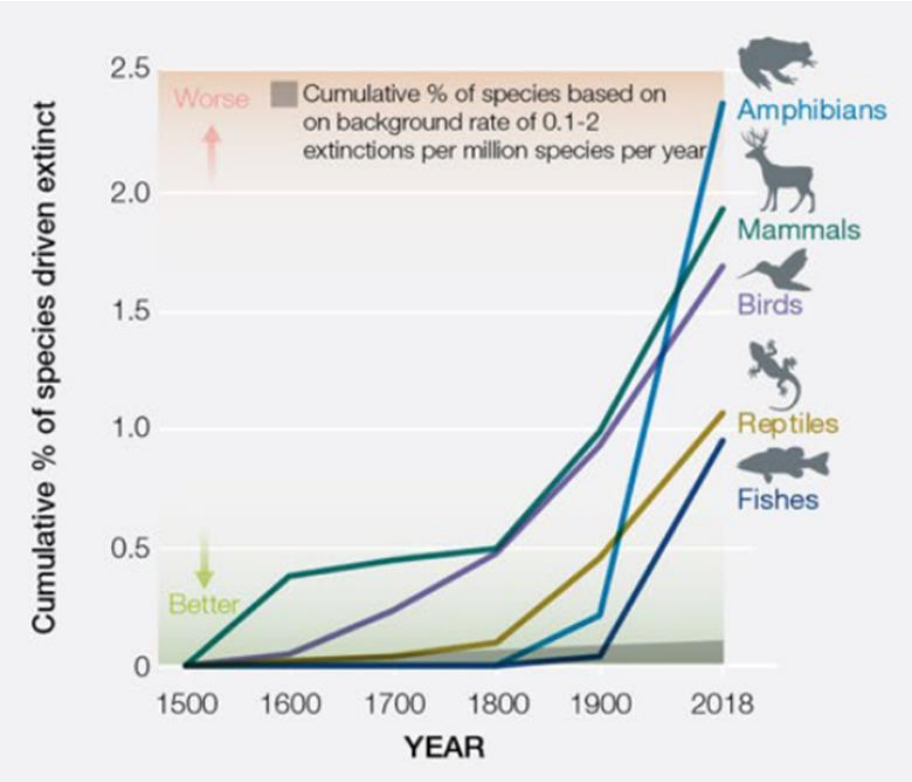
Figure 1. Biodiversity conservation infographic as displayed by the EC Knowledge Centre for Biodiversity. © Paivi Sund

1.1 Global state of play on biodiversity and its conservation

Biodiversity is the diversity of life on earth: of genes, species and ecosystems. In addition to its intrinsic value, it underpins the ecosystem services that sustain our lives in multiple ways. They provide food, water and medicine; ensure soil and water regulation, pollination, erosion and flood control, disease control, and carbon storage. Biodiversity is indispensable for climate change mitigation and adaptation [1], and for maintaining human health [2]. It also enhances recreational activity, creative inspiration and cultural heritage.

[1] https://knowledge4policy.ec.europa.eu/biodiversity_en

Figure 2. Extinctions since 1500 for vertebrate groups. Extinction rates increased sharply in the past century. Source: [4]. Rates for reptiles and fishes have not been assessed for all species. *Source*: IPBES (2019)



And yet, unprecedented economic growth and human intervention are causing biodiversity loss at equally unprecedented rates. Changes in biodiversity were more rapid in the past 50 years [3] than at any time in human history, and are projected to continue or accelerate. The planet lost [4] 87% of its wetlands between 1700 and 2000, 38% mangroves up to 2010, half its live coral cover since the 1870s, and one-third of its forests to date. A global meta-analysis showed a decline of 40% in invertebrate abundance over past 40 years [5]. Current species extinction rates are estimated at 100 to 10,000 times higher [6] than over the past tens of millions of years. 30% tree species are threatened [6] with extinction. Forest fragmentation [7] has reduced biodiversity by as much as 75% [8] in some cases. The biodiversity of freshwater ecosystems [9] (which includes one-third of all vertebrate species) is declining dramatically: globally, wetlands are vanishing three times faster than forests, and freshwater vertebrate populations have fallen more than twice as steeply as terrestrial or marine populations.

Global response to this crisis [10] includes concrete commitments under the UN Convention on Biodiversity (CBD) to safeguard entire natural systems and the life-supporting services they provide. While none [11] of the 20 Aichi Biodiversity Targets for 2020 [12] was fully met at the global level, the post-2020 global biodiversity framework adopted at COP-15 in December 2022 aims at fortified efforts and investment via four long-term goals for 2050 and 23 targets for urgent action by 2030 [13]. Biodiversity conservation includes protecting and restoring nature, as well as mitigating direct and indirect pressures on biodiversity.

Protection measures generally involve creating or expanding protected areas (PAs), i.e. *clearly defined geographical spaces, recognized, dedicated and managed through legal or other effective means to achieve the long-term conservation of nature with associated ecosystem services and cultural values* [14]. Worldwide, over 270,000 designated PAs cover about 15% of terrestrial and freshwater environments and 8% of the marine realm[2]. However they only partly cover important sites for biodiversity and are not yet fully ecologically representative and effectively or equitably managed; only an estimated 20% of PAs are being managed well [6]. Larger and more strictly protected areas are considerably more effective [15] for

[2] Latest statistics estimated by https://dopa-services.jrc.ec.europa.eu/services/, based on the February 2023 version of the World Database on Protected Areas (WDPA).

conservation. PAs need to be extended and integrated into the surrounding land and sea, involve local and indigenous communities, and have resources allocated for better management. More investment in PAs is crucial, and the funds required are small [6]. To protect 30% of the world's land and ocean, and manage the areas effectively by 2030 would require an estimated average investment of $140 billion annually: only 0.16% of global GDP, and less than one-third [16] of the global government subsidies currently supporting activities that destroy nature. The benefits, even when confined to financial benefits, exceed the costs significantly.

Restoration is more complicated than protection. While it could take decades for a rainforest to tip over into a savannah, or just hours for the eutrophication of a pond, reversing the process is difficult and costly – and sometimes impossible. Rainforests that tipped over into savannahs, for instance, can never be retrieved. While avoiding the degradation of nature should take priority, much of global biodiversity lies outside PAs. Restoration measures – habitat management, rewilding, natural regeneration and sustainably productive lands and seas – also play an essential role. Modern agriculture has diminished biodiversity via intensive farming methods such as monocultures and excessive use of chemicals. Restoration can transform degraded areas to landscapes providing multiple ecosystem services, balancing provisioning with regulating services via sustainable land management, including shifting cultivation and crop rotation, and greater incentives to farmers to adopt practices supporting biodiversity and ecosystem services. Nature-based solutions (NBS) [1] can play a key role.

The main direct drivers of biodiversity loss are changes in land and sea use, overexploitation, climate change, pollution, and invasive alien species. In addition to dedicated policies to mitigate these direct drivers, NBS, nature-friendly agriculture, sustainable fisheries and the restoration practices described above can reduce their impact. Most importantly, biodiversity needs to be mainstreamed across all productive and extractive sectors [4] such as mining, fisheries, forestry and agriculture. Moreover, the direct drivers cannot be adequately mitigated without addressing their underlying causes or indirect drivers of biodiversity loss: unsustainable patterns of production, consumption, resource use and trade. These patterns are strongly entrenched in societal values and behaviours, and can only be mitigated through transformative change [4]: fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms, goals and values. Both direct and indirect drivers of biodiversity loss have accelerated in the past 50 years [4].

2 EU action on biodiversity conservation

THE CONTEXT: A STATE OF URGENCY

Europe has a rich diversity of unique wild plant and animal species and habitats, many of which exist nowhere else in the world. But many are in danger; over a quarter of Europe's animal species are at risk of extinction. 1 in 3 bee, butterfly and hoverfly species are in decline, while around 1 in 3 hoverfly and 1 in 10 bee and butterfly species are threatened with extinction [17]; 39% of bird species (a 7% increase since 2012) and 81% of habitats are in poor or bad conservation status [18]. The worst affected habitats are wetlands, peatlands, grasslands and dune habitats. Europe's marine biodiversity too is under pressure [19]: a high proportion of marine species is in an unfavourable conservation status, and there is inadequate information to analyse the status of many marine species and habitats. On the other hand, every euro invested in nature restoration adds €8 to €38 in benefits [20]. The loss of wild pollinators is a case in point. Around 80% of crop and wild-flowering plant species in the EU depend, at least in part, on animal pollination [21]. Without pollinators, many plant species would decline and eventually disappear along with the organisms that depend on them, threatening the survival of nature, human wellbeing and the economy.

Agricultural intensification is one of the main causes of biodiversity loss and ecosystem degradation in Europe. It has transformed formerly diverse landscapes [22], consisting of many small fields and habitats, into uniform terrain managed with large machines – leading to a decline in the abundance and diversity of natural vegetation and animals. The EU's multifunctional forests serve environmental, economic and social purposes. Although forest cover has grown in the past 30 years, the condition of forests [23] is deteriorating. The use of Europe's seas is taking its toll on marine ecosystems: from changes in the composition of marine species and habitats to a shift in the seas' overall physical and chemical characteristics [19]. Sustainable management practices will be key to combating and reversing biodiversity loss while continuing to derive benefits from these sectors.

Figure 3. On a positive note, according to the 2021 European Red List of Birds, the populations of certain species such as this Red Kite (Milvus milvus) are no longer declining thanks to conservation measures such as legal protection, ceasing the use of certain chemicals or creating new nesting opportunities. *Source*: © 542273153 by Ben Seiferling - stock.adobe.com 2023

The EU failed to meet its headline target to halt and reverse overall biodiversity loss by 2020 [24], and did not meet the voluntary target to restore at least 15% of degraded ecosystems (in line with Aichi Target 15 of the CBD). New and enhanced approaches are needed in light of all these facts, and are being adopted in all relevant sectors, and at multiple levels in European actions to 2030, 2050, and beyond. EU action on

biodiversity conservation consists mainly of the relevant EU policies [described in Section 2.1] and EU support for projects and initiatives on biodiversity conservation [Section 2.2].

2.1 EU policies on biodiversity conservation

The mid-term review (2015) of the EU Biodiversity Strategy to 2020 concluded the EU was not on track to deliver for all but one of its six biodiversity targets. Target 5, combating invasive alien species, had both actions implemented, but only limited progress made on the target. Efforts were thereafter stepped up guided by the EU Roadmap for enhanced implementation (2016). However, despite increased efforts, the evaluation (2022) of the EU Biodiversity Strategy to 2020 [24] concluded that targets were not achieved. The EU fell short of achieving its headline target to halt and reverse biodiversity loss in the EU by 2020, and did not fully achieve any of the other targets. Many pressures on ecosystems are stable or increasing, exacerbated by the growing impacts of climate change and invasive alien species. At the same time, progress made in certain areas shows that a persistent implementation effort can be effective. These include pollution reduction, air and water quality, increased share of organic farming, forest expansion, positive trends in some species assessments, and a number of marine fish stocks reaching sustainable levels. The evaluation was based on five criteria: effectiveness, efficiency, relevance, coherence and EU added value. Overall, the Biodiversity Strategy to 2020 did not succeed in establishing a robust governance framework that could ensure urgent implementation efforts at scale, sufficient financing commitment as well as ownership and responsibility by all actors for delivering the biodiversity targets. In the agricultural sector in particular [22], the formulation of targets and actions made it difficult to measure progress.

Figure 4. This Japanese beetle, Popillia japonica, is an invasive species spotted for the first time in Europe (Italy) in 2014, categorised as a pest in the Union territory since 2019. It can feed on leaves from hundreds of plants and trees, showing a preference for leaves of grapes, fruit trees and soy. *Source*: © 114816156 by Philip Steury - stock.adobe.com 2023.

The new EU Biodiversity Strategy to 2030 (EU-BDS 2030) [25] responds to these weaknesses, drawing upon key lessons emerging from evaluations and impact assessments of the previous strategy, as well as implementation experience and exchanges with stakeholders. The new strategy provides a comprehensive EU framework with concrete, time-bound and measurable targets and a strong focus on win-win solutions for biodiversity, health, climate and development, as well as a range of policy instruments to ensure their delivery, with clearly assigned responsibility for implementation.

The first two pillars of the new strategy (EU-BDS 2030) are devoted respectively to protecting and restoring nature, as well as reducing direct pressures such as pollution and invasive species, along with several other policies. Its action plan includes proposing legally binding nature restoration targets, which engendered the

flagship proposal (2022) for a nature restoration law [26]. Its 3rd pillar aims to enable the transformative change necessary for addressing underlying indirect drivers of biodiversity loss. Its 4th pillar, which focuses on global biodiversity, also addresses multiple drivers. In addition, a number of other EU policies target specific drivers of biodiversity loss.

The following sections 2.1.1 to 2.1.4 describe EU policies addressing each of the 4 categories of biodiversity conservation measures: protection, restoration, and the reduction of direct and indirect pressures on biodiversity. However, it should be noted that there are significant overlaps between actions addressing these four categories.

Readers will find on the next page a summary table (Table 1) with the policies discussed in the report.

Table 1: Main EU legislations relevant for biodiversity conservation, categorised according to the type of action they cover: biodiversity protection, biodiversity restoration, addressing direct drivers of biodiversity loss, and addressing indirect drivers of biodiversity loss.

Action type			
Overarching: EU Biodiversity Strategy for 2030			
Biodiversity protection	Biodiversity restoration	Addressing direct drivers of biodiversity loss	Addressing indirect drivers of biodiversity loss
Birds and Habitats Directives	Nature Restoration Law	Drivers: Overarching Farm to Fork Strategy, Common Agricultural Policy New EU Forest Strategy for 2030, Regulation on deforestation-free products	Renewed Sustainable Finance Strategy
New EU Forest Strategy for 2030	New EU Forest Strategy for 2030	Driver: Changes in land and sea use EU Regional and Urban Policy Marine Strategy Framework Directive, Common Fisheries Policy	Horizon Europe strategic research agenda Council Recommendation on learning for environmental sustainability
Green Infrastructure (GI) Strategy	Green Infrastructure (GI) Strategy	Driver: Overexploitation EU Wildlife Trade Regulations Marine Strategy Framework Directive, Common Fisheries Policy	Farm to Fork Strategy
EU Pollinators Initiative	EU Pollinators Initiative	Driver: Climate change EU Climate Law, EU Climate Pact, EU Climate Adaptation Strategy	
Zoos Directive	Farm to Fork Strategy Common Agricultural Policy	Driver: Pollution Zero Pollution Action Plan (ZPAP) EU Chemicals Strategy for Sustainability	
Marine Strategy Framework Directive Common Fisheries Policy	Marine Strategy Framework Directive Common Fisheries Policy	Driver: Invasive alien species EU Invasive Alien Species Regulation	
Water Framework Directive	Water Framework Directive		
EU Climate Adaptation Strategy	EU Climate Adaptation Strategy		

2.1.1 EU policies addressing biodiversity protection

In pillar 1 of the EU-BDS 2030, the EU commits to protecting nature by improving and widening its network of protected areas (PAs). By 2030 it aims to legally protect a minimum of 30% of EU land area and of EU sea area, and to strictly protect at least a third of these PAs, including all primary and old-growth forests. It aims to effectively manage and monitor all PAs, defining clear conservation objectives and measures, and to integrate ecological corridors as part of a Trans-European Nature Network. Many of these goals are supported and implemented by the New EU Forest Strategy for 2030 [27], the action plan to conserve fisheries resources and protect marine ecosystems [28], the new climate strategies and laws [29-31], and actions and strategies in other sectors under the European Green Deal.

In 2021, protected areas covered 26% of the EU's land and 12% of its seas[3]. Still, the relatively small area of the sites may limit their role for biodiversity conservation. 90% of the terrestrial sites measure less than 1000 ha[4] and 50% of the marine sites measure less than 3000 ha[5]. The coherence of the protected area networks, their connectivity and the effectiveness of their management have not yet been measured and evaluated at EU level.

The EU Nature Directives, namely the Habitats Directive (1992) [32] and Birds Directive (2009) [33], require MS to ensure both the physical protection of individual species as well as the conservation of core breeding and resting sites for rare and threatened species under the Natura 2000 network, the world's largest coordinated network of protected areas covering over 26 000 sites. Over 1000 animal and plant species, as well as 200 habitat types, are protected under the Habitats Directive via inclusion in Natura 2000, various protection regimes, and other measures. The Birds Directive protects around 500 wild bird species naturally occurring in the EU via measures ranging from Special Protection Areas, restrictions on hunting, trade and other activities that threaten birds, to promoting research on protection and management. A fitness check (2016) of the Birds and Habitat Directives [34] concluded that, while both remain highly relevant within the broader framework of EU biodiversity policy, full achievement of their objectives would depend on substantial improvement in implementation. The EU Action Plan for nature, people and the economy [35] was developed and adopted (2017) to improve implementation. However, the evaluation of the EU Biodiversity Strategy to 2020 [24] concluded that only 15% of habitat assessments under the Habitats Directive show good status (a further deterioration since 2010). While it is estimated that about 93% of the mapped primary and old-growth forests are part of the Natura 2000 network, these figures should be considered with caution [36] due to mapping deficits and an unclear legal framework. Strict protection of primary and old-growth forests is an urgent priority requiring robust and up-to-date spatially-explicit data, and an efficient monitoring system.

The Natura 2000 network forms the backbone of EU green infrastructure (GI), and lies at the core of the EU GI Strategy (2013) [37]. GI is a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. GI also includes green spaces outside Natura 2000, such as parks, gardens, hedges, green verges and high-diversity agricultural landscapes, green roofs and walls, eco-bridges and fish ladders. In 2019 some progress was reported [38] in GI deployment, but it needs to be scaled up. In particular it was noted that the Nature Directives are less effective in maintaining GI outside of Natura 2000. A broader coverage across all ecosystems is also one of the gaps that the new Biodiversity Strategy and the Nature Restoration Law are covering.

The EU pollinators initiative (adopted in 2018) [39] was the first-ever EU framework directed at tackling the decline of wild pollinators. It proposed ten specific actions categorised under three priorities, to be implemented until 2020 with a long-term perspective towards 2030. In 2021 significant progress was reported in its implementation [21], and in policy enablers to monitor pollinator species following an EU standardised methodology [40] which is currently fine-tuned and the drivers of their decline. However the progress report pointed to significant remaining challenges in tackling these drivers, in particular in addressing the loss of habitats in farming landscapes, and the impacts of pesticides. The report also called for a pollinator-information system and tailored research to support the Initiative. The revised initiative "A new deal for pollinators" [17] in January 2023 has eleven specific actions to be achieved by 2030, categorised under slightly revised priorities: (i) Improving knowledge of pollinator decline, its causes and consequences; (ii)

[3] https://dopa.jrc.ec.europa.eu/kcbd/dashboard/
[4] https://www.eea.europa.eu/en/topics/in-depth/biodiversity/an-introduction-to-europes-protected-areas
[5] https://www.eea.europa.eu/publications/marine-protected-areas/marine-protected-areas

Improving pollinator conservation and tackling the causes of their decline; and (iii) Mobilising society and promoting strategic planning and cooperation at all levels. The EU-BDS 2030, Farm to Fork Strategy and Zero Pollution Action Plan are expected to substantially reinforce actions to protect pollinators. The Nature Restoration Law (2022) aims to reverse pollinator decline by 2030.

Figure 5. Left: Lago Nero located within the Italian Natura 2000 site Alpi Veglia e Devero. Right: one adult and several tadpoles of Triturus alpestris living in Lago Nero. Picture: © European Union 2023.

The EU regulates the role of zoos in ex-situ biodiversity conservation via the Zoos Directive (1999) [41]. A recent evaluation (2018) [42] declared it plays a small but necessary role within a wider legislative framework, and is coherent with EU legislation on biodiversity conservation. However, improved implementation is required to achieve its full potential.

Regarding marine ecosystems, the Marine Strategy Framework Directive (MSFD, 2008) [43] aims at more effective protection of the marine environment while ensuring the sustainable use of marine resources. It calls for spatial protection measures contributing to an effective and coherent protected area network. The Directive was supplemented by revised criteria and methodological standards (2017) for implementation by MS [44]. The report (2020) on the implementation of the MSFD [45] shows that, while the EU's framework for marine environmental protection is one of the most comprehensive and ambitious worldwide, it needs to be beefed up to be able to tackle predominant pressures. Thus, the Biodiversity Strategy has put in place an action plan to conserve fisheries resources and protect marine ecosystems [28] and other actions under the common fisheries policy. In 2022, the Commission adopted an implementing regulation closing 87 areas to all bottom fishing gears [44] in the EU waters of the North-East Atlantic, thus protecting 57 vulnerable deep-sea ecosystems, in line with the Deep-sea access regulation [47] of 2016.

Regarding freshwater ecosystems, the Water Framework Directive (WFD, 2000) [48] sets rules to achieve good ecological and chemical status for Europe's rivers, lakes and groundwater, so that both humans and wildlife have enough quantity and quality of fresh water. It requires the protection and, where necessary, the restoration of water bodies in order to reach good status. In terms of protection, the WFD calls for the establishment and register of protected areas to ensure certain water uses, certain water quality and the protection of particular species and habitats (overlapping or complementing Natura 2000 sites). The comprehensive framework set by the WFD was complemented by the BDS and the NRL with a special focus on safeguarding free flowing rivers. In October 2022, the Commission adopted a proposal to amend the WFD [49] including additional pollutants and more frequent access to monitoring data.

2.1.2 EU policies addressing biodiversity restoration

Nature restoration is covered under pillar 2 of the EU-BDS 2030. Priorities include bringing nature back to agricultural land, restoring soil ecosystems, increasing forested land, restoring marine and freshwater ecosystems, and greening urban and peri-urban areas. Pillar 2 included a proposal for legally binding restoration targets. This led to the adoption of the Proposal for a Nature Restoration Law (NRL) [26] in 2022, designed to put all natural and semi-natural ecosystems on the path to recovery by 2030. Its targets include those based on the Nature Directives (now with quantitative targets and deadlines) but also cover other

ecosystem types more broadly (e.g. cities, forests, cropland, grassland, all the EU's seas but with a focus on key marine habitats). The NRL will be supported by the New EU Forest Strategy for 2030 [27], the Farm to Fork Strategy [50], and several actions under the common fisheries policy and other sectors.

Key commitments under the Nature Restoration Law, as adopted by the European Parliament on 12 July 2013[6], are:

- For terrestrial, coastal and freshwater as well as marine ecosystems: restoring at least 20% of the area of each habitat type not in good condition by 2030, and by 2050 all ecosystems in need of restoration. This includes habitats of all threatened species listed in the Habitats Directive, as well as others.
- For habitat types not covered by the Habitats Directive, the NRL lays down the following specific measures:
    - For urban ecosystems: no net loss of urban green space and urban tree canopy cover by the end of 2030
    - For rivers and floodplains: removing river barriers [51] to enable at least 25,000 km of free-flowing rivers by 2030
    - For pollinator populations: reversing their decline by 2030 and achieving thereafter an increasing trend, measured every 6 years after 2030 until satisfactory levels are achieved
    - For forest ecosystems: implementing restoration measures for enhancing biodiversity and achieving increasing trends of each of the following indicators: i) share of forests with uneven-aged structure, (ii) forest connectivity, (iii) organic carbon stock (iv) share of forests dominated by native tree species (v) tree species diversity;

Nature-based solutions (NBS) [1] play a key role in biodiversity restoration while providing multiple benefits for climate change mitigation and adaptation, and creating new employment opportunities in rural areas. They form a core ingredient of the EU-BDS 2030, the new EU Climate Adaptation Strategy [31], the European Climate Law [29], as well as other EU policies. For more background on EU investment in NBS, see Section 2.1.1 in Ref [1].

2.1.3 EU policies addressing direct drivers of biodiversity loss

The direct drivers of biodiversity loss are changes in land- and sea-use, overexploitation, climate change, pollution and invasive alien species. Many activities, such as agriculture, fisheries, urban expansion and trade, contribute to multiple drivers. Addressing the impact of these drivers on biodiversity requires cooperation between different EU policy domains, as well as strong international cooperation, because climate change and trade are global issues, and invasive species cross borders.

Many EU-BDS 2030 measures for protection and restoration (pillars 1 and 2) described in previous sections also address these direct drivers, for instance via targets and incentives for restoring carbon-rich ecosystems including forests and peatlands, and enabling climate- and nature-friendly farming practices. In addition, other EU policy domains are dedicated to addressing specific drivers of biodiversity loss such as climate change and pollution.

Intensive agriculture exacerbates several drivers of biodiversity loss, in particular land-use change, climate change and pollution. While 77% of the EU budget for biodiversity over the 2014-2020 period came from the common agricultural policy (CAP), this contribution did not halt the decline of farmland biodiversity [22], and efforts to enable nature-friendly agriculture need to be stepped up. Targets for nature-friendly agriculture under pillar 2 include reducing pollution from chemical pesticides and fertilisers, expanding organic farming and high-diversity landscape features that enhance carbon sequestration, increased agro-forestry and urban greening. Most of these targets are also part of the Farm to Fork Strategy (2021) [50], which aims to make EU food systems more sustainable. The new Common Agricultural Policy (2023–2027) aims to raise the green ambitions of EU agriculture, in order to bring them in line with environmental and climate legislation. It is seen as a key tool for realising the ambitions of the Farm to Fork and Biodiversity Strategies. Details on biodiversity and agriculture will appear in a separate report [52] in this series.

[6] https://www.europarl.europa.eu/doceo/document/TA-9-2023-0277_EN.html

Pesticide pollution has short-term effects on directly exposed organisms as well as long-term effects on biodiversity from changes in habitat and food chains. It is specifically addressed in pillar 2 in tandem with the Zero Pollution Action Plan (ZPAP) [53] and the EU Chemicals Strategy for Sustainability [54]. Key commitments under the EU-BDS 2030 and ZPAP include halving by 2030 the use and risk of chemical pesticides and the use of the more hazardous ones. In 2022 the Commission adopted flagship legislative proposals [55] to make these commitments for pesticide use legally binding, including strict new rules to ensure environmentally friendly pest control and a ban on pesticide use in sensitive areas. Excessive fertiliser use affects biodiversity through eutrophication of water bodies and soil acidification due to nutrient runoff (mainly nitrogen and phosphorus). The EU-BDS 2030 and ZPAP commit to reducing pollution from fertiliser use by halving nutrient losses, thereby reducing the use of fertiliser by 20%. ZPAP targets also include the reduction by 25% of EU ecosystems where air pollution threatens biodiversity, by 50% plastic litter at sea, and by 30% microplastic release into the environment. Further details on the impacts of pollution on biodiversity and health, as well as the relevant EU policies, are available in a separate report [2] in this series, focusing on biodiversity and health.

Apart from EU-BDS, changes in land-use, overexploitation and climate change are influenced by forest strategy. Changes in land-use are also influenced by EU Regional and Urban Policy [54], whose specific objectives include environmental protection, a low carbon economy and climate change adaptation. EU action to protect forests needs strengthening [23], in particular to tackle biodiversity and climate change, combat illegal logging and better focus rural development forestry on biodiversity and climate change. These challenges are addressed under the New EU Forest Strategy for 2030 [27] and the Proposal for a regulation on deforestation-free products (2021) [57], which aims to guarantee to EU citizens that the listed products they buy, use and consume do not contribute to global deforestation and forest degradation. The regulation was adopted in May 2023 [58]. Overexploitation is further regulated by EU legislation on wildlife trade [59]. Most of EU action on wildlife trade derives from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In addition, the EU prohibits trade in seal products [60] and regulates hunting and trapping methods [61] to ensure they are as humane as possible. CITES is implemented in the EU through the EU Wildlife Trade Regulations [59].

The fisheries industry contributes to changes in sea-use and to overexploitation and pollution of marine resources. The EU-BDS 2030 emphasises the sustainable harvest of marine resources and zero tolerance for illegal exploitative practices. Its EU Nature Restoration Plan for 2030 commits to substantially reducing negative impacts on sensitive marine species and habitats, including on the seabed through fishing and extraction activities. The MSFD implementation report (2020) [45] pointed to the persisting need to tackle predominant pressures such as overfishing and unsustainable fishing practices, plastic litter, excess nutrients, underwater noise and others types of pollution. These pressures and EU-BDS 2030 commitments are being addressed and implemented by the MSFD itself and via initiatives under the Common Fisheries Policy and the ZPAP. The new action plan to conserve fisheries resources and protect marine ecosystems [28] aims to address the by-catch of sensitive species and adverse impacts on sensitive habitats through technical measures such as area closures, gear changes and mitigation measures for sensitive species. In line with the Deep-sea access regulation (2016), the Commission adopted (2022) an implementing regulation closing 87 areas to all bottom fishing gears [46] in the EU waters of the North-East Atlantic.

Climate change is of course also addressed directly via EU climate policy. The European Climate Law [29] commits the EU to climate-neutrality by 2050 and sets an immediate target of at least 55% net reduction in GHG emissions by 2030 compared to 1990 levels. It aims to achieve this mainly by cutting emissions, investing in green technologies and protecting the natural environment. The new EU adaptation strategy (2021) [31], the Climate Law [29], the new EU Forest Strategy for 2030 [27] as well as other EU strategies addressing climate and biodiversity identify nature-based solutions as key win-win solutions. On the other hand, some aspects of climate mitigation actions, such as renewable energy expansion and negative emission technologies, could pose a threat to biodiversity if nature concerns are not adequately addressed right from the planning phase. Details on EU policies addressing the biodiversity, climate change and energy nexus are available in a separate report [1] in this series.

Pillar 2 of EU-BDS 2030 includes stepping up the implementation of the EU Invasive Alien Species Regulation (2014) [62] and other relevant legislation in order to minimise, and where possible eliminate, the introduction

and establishment of alien species in the EU environment. It commits to reducing by 50% the number of species on the European red list[7] that are threatened by invasive alien species.

Figure 6. The angelshark (Squatina squatina) lives in shallow European waters around the Northeast Atlantic Ocean and the Mediterranean Sea. It has been assessed by the IUCN Red List of Threatened Species in 2017 as 'critically endangered' and its range and abundance are declining. Picture: © 560511156 by IKER - stock.adobe.com 2023.

2.1.4 EU policies addressing indirect drivers of biodiversity loss

The main indirect drivers of biodiversity loss are the unsustainable patterns of production, consumption, resource use and trade underlying the direct drivers discussed in the previous section. These patterns are entrenched in societal values and behaviours, and can only be tackled via transformative change: fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms, goals and values. In recognition of this fact, pillar 3 of the EU-BDS 2030 is dedicated to enabling transformative change, which in turn calls for transformative governance. Pillar 3 proposes a new European biodiversity governance framework to build on an integrated whole-of-society approach while stepping up implementation and enforcement of EU environmental legislation. A roadmap will map biodiversity commitments and guide their implementation. Its key elements include administrative capacity building, transparency, stakeholder dialogue, and participatory governance towards ensuring co-responsibility and co-ownership by all relevant actors. In 2023 the Commission will assess the progress and suitability of this governance framework, and consider whether a legally binding approach is needed.

Finance and pricing

The governance framework introduces a new (2021) initiative on sustainable corporate governance [63] to embed social and environmental interests into business strategies. This includes improved measurement of the impacts of economic activities and of public and private capital flows on biodiversity, reducing harmful impacts and re-orienting investment towards environmentally sustainable activities. The EU Sustainable Finance Taxonomy Regulation (2020) [64] will guide investment towards a green transition and NBS deployment. A new delegated act (2023) under the regulation will cover, inter alia, economic activities contributing to the protection and restoration of biodiversity and ecosystems [65, 66]. The Renewed Sustainable Finance Strategy (2021) [67] extends the scope of the taxonomy and presents a variety of other initiatives to help meet the investment needs of the sustainability transition and increase the financial sector's resilience and contribution to sustainability. Another key element of the framework, the new Corporate Sustainability Reporting Directive [68], entered into force in January 2023. It strengthens the existing reporting requirements of businesses under the Non-Financial Reporting Directive [69] with a view to

[7] The European Red List (IUCN): https://www.iucnredlist.org/regions/europe

enhancing the scope and quality of environment-related disclosures. A first set of European Sustainability Reporting Standards, covering biodiversity as well as other environmental objectives, should be adopted in the course of 2023.

Transformative change includes better integrating the value of nature in production systems as well as decision-making. In order to shift the tax burden from labour to pollution, under-priced resources and other externalities, the EU is promoting tax systems and pricing that reflect environmental costs, such as biodiversity loss, via 'user pays' and 'polluter pays' principles. Biodiversity considerations are being integrated in decision-making via methods such as life-cycle analyses and natural capital accounting to measure the environmental footprint of products and organisations.

Private and public funding of at least € 20 billion annually, needed for investment in Natura 2000, green infrastructure and other NBS [1], will be mobilised via relevant programmes in the next long-term EU budget (i.e. programmes dedicated to environmental protection, such as Life, as well as other relevant programmes – under the common agriculture policy, cohesion policy, etc.). Investment in nature and biodiversity is also covered under the Invest EU Programme[8] [70] and is a priority for the European Green Deal Investment Plan.

Research, innovation and knowledge

One of the first actions implemented under the EU-BDS 2030 was the establishment of the European Commission's Knowledge Centre for Biodiversity[9], primarily to track progress by the EU and its partners implementing EU and international biodiversity commitments; to foster cooperation and partnership; and to underpin policy development.

Research, innovation and knowledge exchange will be key to gathering the best data and developing ways to prioritise 'green' over 'grey' solutions towards transformative change. The Horizon Europe (HE) long-term strategic research agenda for biodiversity includes a dedicated Science Service for Biodiversity [70] to provide decision makers with timely research-based options for policymaking on biodiversity, and step up research-based implementation of biodiversity commitments. The Science Service, being developed by the BioAgora consortium,[10] will provide a scientific pillar to the EC's Knowledge Centre for Biodiversity.

HE missions will help fill knowledge gaps towards improving ecosystem health. A dedicated European Biodiversity Partnership, Biodiversa+[11], was launched in 2021 to make the bridge between science, policy and practice, and put nature on a path of recovery. See Section 2.2.1.3 on HE projects for more details on Biodiversa+. The new European Skills Agenda[12], focused on training and re-skilling the workforce across sectors, will play a key role in the green transition and the fight against biodiversity loss. A Council Recommendation on learning for environmental sustainability (2022) [71] will help integrate biodiversity and ecosystems into school, higher education and professional training. See also our report on biodiversity and education [72], part of this series.

Transformative change in the food system

Intensive agriculture and food systems have caused biodiversity loss via land-use change, climate change, pollution and overexploitation. Apart from addressing these direct drivers via concrete targets for sustainable agriculture described in the previous section, the Farm to Fork Strategy [50] aims to tackle indirect drivers through transformative change in the European food production system. In addition to agriculture, manufacturing, processing, retailing, packaging and transportation of food make a major contribution to air, soil and water pollution and GHG emissions, and have a profound impact on biodiversity. On the other hand, environmental degradation and biodiversity loss have contributed to reducing the resilience and sustainability of food systems against recurring droughts, floods, forest fires and pest-and-disease outbreaks.

The Farm to Fork Strategy aims to reduce the environmental footprint of the EU food system and strengthen its resilience, ensure health, social benefits, and food security in the face of climate change and biodiversity loss, and lead a global transition towards competitive sustainability from farm to fork. It aims to ensure that the food chain – covering food production, transport, distribution, marketing and consumption – has a neutral or positive environmental impact, preserving and restoring the land, freshwater and sea-based resources on

[8] https://investeu.europa.eu/index_en
[9] https://knowledge4policy.ec.europa.eu/biodiversity_en
[10] https://bioagora.eu/science-service-for-biodiversity/
[11] https://www.biodiversa.eu
[12] https://ec.europa.eu/social/main.jsp?catId=1223

which the food system depends; helping mitigate climate change and adapt to its impacts; protecting land, soil, water, air, plant and animal health and welfare; and reversing the loss of biodiversity.

2.2 EU-supported projects and initiatives on biodiversity conservation

European projects are mainly listed below, while global conservation-related projects and initiatives supported by the EU are listed under a separate report [10] in this series, which focuses on biodiversity and its global governance.

2.2.1 RTD (Research & Innovation) support

A large number of Research & Innovation (RTD) programmes under FP7 (2007-13)[13] and Horizon 2020 (2014-20)[14] have supported projects relating to biodiversity conservation. Calls under the first phase of the new Horizon Europe (2021-27)[15] are ongoing, and have been listed in the HE Work programme for 2021-22 and the HE Work programme for 2023-24.

2.2.1.1 FP7 (2007-2013) programmes that covered biodiversity conservation

Specific Programme "Cooperation": Environment (including Climate Change) (FP7-Environment) aimed at improving the sustainable management of environmental resources by advancing knowledge on interactions between the climate, biosphere, ecosystems and human activities via multidisciplinary research. Areas addressed included biodiversity conservation and sustainable management, environmental pressures, marine environment management, earth and ocean observation and monitoring, and nature restoration. Among its actions most relevant for biodiversity conservation were "Biodiversity values, sustainable use and livelihoods," "Improving the capacity to protect and manage the biodiversity of continental waters," "Scale dependency of sustainable use of biodiversity," "Assessment of economic instruments to enhance the conservation and sustainable use of biodiversity," "Mobilising environmental knowledge for policy and society," and "Developing a European scientific biodiversity Network to inform policy-making and economic actors."

Specific Programme "People" (FP7-People) aimed at stimulating individuals to enter the research profession. It supported a number of research projects on biodiversity conservation via actions such as "Marie Curie Action: International Incoming Fellowships," "Marie Curie Action: International Outgoing Fellowships for Career Development," "Marie-Curie Action: Intra-European fellowships for career development," "Marie Curie Action: International Research Staff Exchange Scheme," and "Marie-Curie Action: Career Integration Grants."

Specific Programme "Ideas" (FP7-Ideas-ERC) implemented by an autonomous European Research Council (ERC), aimed at developing high-level frontier research at European level. It supported a number of research projects on biodiversity conservation via actions such as "ERC Starting Grant - Evolutionary, population and environmental biology" and "ERC Consolidator Grant - Environment, Space and Population."

2.2.1.2 Horizon 2020 (2014-2020) programmes that covered biodiversity conservation

Pillar III (SOCIETAL CHALLENGES): Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy (H2020-EU.3.2) aimed to secure sufficient supplies of safe, healthy and high-quality food and other bio-based products by developing productive, sustainable and resource-efficient primary production systems, fostering related ecosystem services and the recovery of biological diversity. Among its actions most relevant for biodiversity conservation were "Sustainable agriculture and forestry" (H2020-EU.3.2.1) and "Cross-cutting marine and maritime research" (H2020-EU.3.2.5).

Pillar III (SOCIETAL CHALLENGES): Climate action, Environment, Resource Efficiency and Raw Materials (H2020-EU.3.5) aimed to achieve a resource- and water-efficient and climate change-resilient economy and society, protect and sustainably manage natural resources and ecosystems, and ensure a sustainable supply and use of raw materials. Among its actions most relevant for biodiversity conservation is "Protecting the environment, sustainably managing natural resources, water, biodiversity and ecosystems" (H2020-EU.3.5.2), which included funding (€ 3 million) the project "Europa Biodiversity Observation Network: integrating data

[13] https://cordis.europa.eu/programme/id/FP7
[14] https://ec.europa.eu/environment/integration/research/2020_en.htm
[15] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

streams to support policy," or EuropaBON, and co-funding (€ 12.9 million) the project "Consolidating the European Research Area on biodiversity and ecosystem services," or BiodivERsA3. Biodiversity conservation was also covered under actions "Fighting and adapting to climate change" (H2020-EU.3.5.1) and "Developing comprehensive and sustained global environmental observation and information systems" (H2020-EU.3.5.5). The H2020 Green Deal Call "Restoring biodiversity and ecosystem services" (LC-GD-7-1-2020) funded large-scale demonstration projects on restoration as well as systemic upscaling and replication of best practice ecosystem restoration.

Pillar I (EXCELLENT SCIENCE): Marie Skłodowska-Curie Actions (H2020-EU.1.3) and European Research Council (H2020-EU.1.1) also included several topics relevant to biodiversity conservation.

2.2.1.3 Horizon Europe (2021-2027) ongoing calls/programmes covering biodiversity conservation

Horizon Europe's Pillar II on Global Challenges and European Industrial Competitiveness covers biodiversity conservation mainly under Cluster 6.

The HE Work programme (2021-22) for Cluster 6 and HE Work Programme (2023-24) for Cluster 6 on "Food, Bioeconomy, Natural Resources, Agriculture and Environment" include several destinations relevant for biodiversity conservation. Particularly relevant are calls under destination 1 dedicated to "Biodiversity and ecosystem services." This includes co-funding (€ 40 million) the new European Biodiversity Partnership 'Rescuing biodiversity to safeguard life on Earth' or Biodiversa+ [72], which will connect national, local and European research, innovation and environmental programmes, combining resources in support of one goal: by 2030 biodiversity in Europe is back on the path to recovery. It will co-develop multidisciplinary research and innovation programmes with stakeholders, set up a European network of coordinated observatories for biodiversity monitoring, and implement a broad range of activities to increase the relevance, impact and visibility of EU research and innovation in tackling the biodiversity crisis in line with the EU biodiversity strategy for 2030. Other projects under this destination are encouraged to promote synergies with Biodiversa+, as well as with the ongoing EuropaBON project initiated under Horizon 2020 and other relevant projects and initiatives under this and other destinations. Relevant calls are also covered under destination 2 "Fair, healthy and environment-friendly food systems from primary production to consumption," destination 5 "Land, ocean and water for climate action," destination 6 "Resilient, inclusive, healthy and green rural, coastal and urban communities," and destination 7 "Innovative governance, environmental observations and digital solutions in support of the Green Deal." The corresponding currently running HE projects are classified under the programmes "Biodiversity and Natural Resources" (HORIZON.2.6.2), "Seas, Oceans and Inland Waters" (HORIZON.2.6.4), "Environmental Observation" (HORIZON.2.6.1), "Agriculture, Forestry and Rural Areas" (HORIZON.2.6.3), and "Circular Systems" (HORIZON.2.6.7).

Pillar I (Excellent Science) also continues under HE, with support in the form of grants for the European Research Council, € 830 million for Marie Sklodowska-Curie Actions and € 470 million for Research Infrastructures. Several research projects relevant for biodiversity conservation are included here.

Pillar III (Innovative Europe) includes the European Innovation Council (EIC) and its Pathfinder, Transition and Accelerator actions. It supports SMEs and research teams developing breakthrough innovations with a focus on contributing to objectives of the European Green Deal and the Recovery Plan for Europe. Its programme "EIC Accelerator Challenge – Green Deal innovations for the Economic Recovery" supports projects with sustainability goals, including preserving and restoring ecosystems and biodiversity. Projects relevant for biodiversity conservation are included here.

2.2.2 CINEA support

The European Climate Infrastructure and Environment Executive Agency (CINEA)[16] runs many programmes that fund projects on biodiversity conservation. These include the LIFE programme[17] for environment and climate action, programmes in the maritime sector, and others.

The LIFE programme

[16] https://cinea.ec.europa.eu/our-projects_en
[17] https://cinea.ec.europa.eu/programmes/life_en

In 2021 the Commission approved an investment package of more than €290 million for 132 new projects under the LIFE programme (2021-2027). This EU funding will mobilise a total investment of €562 million. Putting Europe's biodiversity on a path to recovery by 2030 is one of its main goals. It consists of four sub-programmes, one of which is devoted to Nature and Biodiversity. The Nature and Biodiversity sub-programme aims at protecting and restoring Europe's nature, and halting and reversing biodiversity loss. It will fund 39 projects that support the implementation of the Birds and Habitats Directives, as well as EU-BDS 2030, with a total budget of €249 million, of which the EU will pay €134 million.

Earlier LIFE programmes also covered many projects relevant to this topic, which can be searched in the LIFE public database. For instance the ongoing project (2019-25) "Life Connects" (EU co-funding € 5.6 million) aims at improving the conservation status of target species and ecological status of target rivers.

Maritime sector programmes

These are funded via the European Maritime and Fisheries Fund, and projects are listed in the maritime datahub.

3 Conclusions

The fact that urgent action is needed to save European biodiversity can hardly be overemphasised. We have highlighted the main aspects of biodiversity conservation in section 1 and the urgent European context in the introduction to section 2 of this overview. The wide range of measures required for biodiversity conservation are introduced in section 1, and fleshed out in the European context in sections 2.1.1 to 2.1.4, along with the equally wide range of EU actions involved. Most protection and restoration measures are covered by the EU-BDS 2030, and implemented in tandem with the nature directives and other policies relating to specific ecosystem types (forests, marine ecosystems, agri-ecosystems, etc.). In sections 2.1.1 and 2.1.2 we have outlined these efforts. However these efforts cannot succeed without reinforced commitments from a host of other EU policy domains. In particular, mitigating the drivers of biodiversity loss, direct as well as indirect, entails the involvement of policy domains ranging from land-use planning to pollution reduction to food systems, climate change and trade. These are discussed in sections 2.1.3 and 2.1.4. It will thus be imperative to mainstream biodiversity considerations in actions under all these domains for conservation efforts to have a chance of succeeding. These policy domains are in turn closely connected to others, reinforcing the need for transformative change, or system-wide reorganisation across policy domains. We have delineated the linkages between these domains, and the EU policies addressing these linkages, in order to highlight ongoing efforts as well as to help identify potential areas for enhanced future action.

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List of abbreviations

CAP	Common Agricultural Policy
CBD	UN Convention on Biodiversity
CINEA	European Climate Infrastructure and Environment Executive Agency
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP-15	15th Conference of the Parties
ERC	European Research Council
EU	European Union
EU-BDS 2030	EU Biodiversity Strategy to 2030
FP7	7th Framework Programme
GDP	Gross domestic product
GI	Green infrastructure
HE	Horizon Europe
K4P	Knowledge for Policy
KCBD	Knowledge Centre for Biodiversity
MSFD	Marine Strategy Framework Directive
NBS	Nature-based solutions
NRL	Nature Restoration Law
PAs	Protected Areas
RTD	Research & Innovation
SME	Small and Medium Enterprise
WFD	Water Framework Directive
ZPAP	Zero Pollution Action Plan

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