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The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery

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Abstract

The European Union (EU) has committed to an ambitious biodiversity recovery plan in its Biodiversity Strategy for 2030 and the Green Deal. These policies aim to halt biodiversity loss and move towards sustainable development, focusing on restoring degraded habitats, extending the network of protected areas (PAs), and improving the effectiveness of management, governance, and funding.

The achievement of conservation goals must be founded on understanding past successes and failures. Here, we summarise the strengths and weaknesses of past EU biodiversity conservation policies and practices and explore future opportunities and challenges. We focus on four main aspects: i) coordination among and within the EU Member States, ii) integration of biodiversity conservation into socio-economic sectors, iii) adequacy and sufficiency of funds, and iv) governance and stakeholder participation.

Whilst past conservation efforts have benefitted from common rules across the EU and funding mechanisms, they have failed at operationalizing coordination within and across the Member States, integrating biodiversity conservation into other sectoral policies, adequately funding and effectively enforcing management, and facilitating stakeholder participation in decision-making. Future biodiversity conservation would benefit from an extended and better-managed network of PAs, additional novel funding opportunities, including the private sector, and enhanced co-governance. However, it will be critical to find sustainable solutions to potential conflicts between conservation goals and other socio-economic objectives and to resolve inconsistencies across sectoral policies.

Keywords: Coordination, funding, integration, governance, Natura 2000, protected areas

Where do we come from and where do we want to go?

Over the last decades, the European Union (EU) and its Member States have made commitments and set clear goals to halt biodiversity loss, at both continental and global scales (EC, 2011). The achievement of these goals is supported by legal frameworks, such as the Birds and Habitats Directives (Nature Directives hereafter) and the Marine Strategy Framework Directive; policies, such as the EU Biodiversity Strategy; and financial mechanisms, such as the LIFE programme. These legal frameworks, policies and financial support have guided a collective and coordinated effort without precedent globally, and resulted in the designation of the World's largest network of protected areas (PAs): the Natura 2000 network (N2K; Evans, 2012), currently covering 18.5% of the European land area and almost 10% of the total EU marine area (over 550,000 km²; EEA, 2020). The efforts done by the EU in terms of biodiversity conservation are not restricted to continental policy, as the EU has also contributed to the development and subscribed international agreements and conventions, such as the UN Sustainable Development Goals (UN, 2015) or the Convention on Biological Diversity (CBD, 2010), that lead global initiatives for halting biodiversity loss.

This substantial effort has, however, proven insufficient to halt biodiversity loss at the continental scale (EC, 2020a). Despite targets set in the Biodiversity Strategy for 2020 of improving the conservation status of 100% of habitats and 50% of species (EC, 2011), only 15% of habitats and 27% of species listed in the Habitats Directive and 47% of species listed in the Birds Directive are under no foreseeable risk of extinction (EC, 2020a). The insufficient advance towards achieving biodiversity conservation targets is not the only environmental battlefield that the EU faces, as the impacts of global change on society, biodiversity and ecosystem services continue to accelerate (IPBES, 2019).

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In response to these environmental and socio-economic challenges, the EU has recently adopted the European Green Deal, which aims at achieving a sustainable and carbon-neutral economy by 2050 (EC, 2019). In line with the UN Decade of Restoration (UN, 2019), the European Green Deal also represents a strong commitment by the European Commission to legally binding restoration of degraded habitats, the services they provide and the biodiversity they hold, and provides financial support over the next decade for restoring ecosystems (EC, 2019). The European Commission acknowledges in its Green Deal the large contribution that nature and biodiversity make to our economy and health and recognizes the need for conservation action. Therefore, the Green Deal could be the first step towards a paradigm change in the EU, by placing biodiversity conservation at the forefront of continental priorities and fostering the long-demanded need for better integration of biodiversity conservation in other sectoral policies.

The opportunities for biodiversity conservation and restoration are reinforced by the recently adopted Biodiversity Strategy for 2030 (EC, 2020b). This Strategy aims to “Bring nature back into our lives” (EC, 2020b), aligning with the Green Deal objectives, and providing further policy context with specific goals and funding mechanisms. The Biodiversity Strategy for 2030 revolves around three pillars: (i) protecting and restoring nature in the EU, by consolidating a coherent and effective network of PAs and restoring degraded habitats; (ii) enabling a new governance framework to ensure co-responsibility and co-ownership by all relevant actors in meeting the biodiversity commitments, including setting up new financial opportunities; and (iii) adopting a global biodiversity agenda, to strengthen the contribution of the EU towards halting global biodiversity loss and minimizing externalities of EU use of resources and consumption on other biodiversity-rich areas of the planet (EC, 2020b).

However, lessons from the past show that ambitious goals need to be accompanied by adequate planning, enforcement, and governance to be effective (Guidetti et al., 2008; Yates

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et al., 2019). Here, we consider past successes and failures of EU biodiversity policy and practice to make recommendations that support the achievement of the objectives of the Biodiversity Strategy for 2030. We focus on four key aspects for effective policy implementation: i) coordination among and within the EU Member States, ii) integration of biodiversity conservation into other sectors, iii) adequacy and sufficiency of funds, and iv) governance and stakeholder participation. Evaluating and acting upon these aspects will be central in enabling effective conservation in the coming decade. For each of these aspects, we first highlight the strengths and weaknesses of past conservation policy and practice, then explore relevant opportunities and challenges that biodiversity conservation faces in the coming decade. We also highlight some development needs associated with the main policy tools for biodiversity conservation, to make conservation action more effective. We conclude with some insights on how adequate planning can contribute to making the most of the existing opportunities and strengths to overcome some of the past weaknesses and future challenges for a successful implementation of the Biodiversity Strategy for 2030. The implication of potential success of conservation policy in the EU goes beyond the achievement of continental goals, as it could help guide conservation strategies in other parts of the world (Campagnaro et al., 2019) and unite efforts with similar initiatives and conservation goals.

Coordination of conservation efforts and effective management

Strengths: Biodiversity conservation in the EU has benefited over the past decades from standardized policy setting, common objectives, monitoring, and impact assessment protocols across all Member States (Campagnaro et al., 2019). Implementing conservation-focused policy in the EU has led to the unquestionable reinforcement of national systems of PAs under the Nature Directives with a steady expansion of the N2K network. This coordinated

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network of PAs aims to represent populations of species and habitats listed as of conservation interest in both Nature Directives, and foster connectivity amongst them (Maiorano et al., 2015; Saura et al., 2019). Before the establishment of the N2K network, conservation actions across the EU Member States were heterogeneous and lacked coherence (Campagnaro et al., 2019). With the N2K network, site selection and designation are based on common conservation objectives, and the Member States are required to monitor and periodically report on the status of habitats and species and on their main pressures and threats. Such common monitoring and reporting approaches have increased the availability of data throughout the entire EU, which has helped to better guide conservation policies and funding and improved the large-scale effectiveness of conservation efforts (e.g., Mazaris et al., 2019; Vogiatzakis et al., 2020). There are also mechanisms developed to supervise the compliance of the common rules and objectives. For instance, in 2015 the European Commission opened new infringement cases against eight Member States (Greece, Germany, Portugal, Spain, Ireland, Belgium, UK and Italy) for insufficient progress in: i) the designation of PAs, ii) the adoption of conservation objectives, and iii) the implementation of management measures in several biogeographical regions (Milieu et al., 2016).

Weaknesses: Despite the efforts described above, there remains insufficient coordination across and within the Member States in planning the designation of PAs under N2K network (Mazaris et al., 2018). The designation has been largely undertaken following country-based assessments of individual areas in isolation, and cooperation between regional and local authorities and stakeholders has proven deficient (ECA, 2017). For example, Markantonatou et al. (2016) reported inadequate cross-jurisdictional coordination and lack of engagement between the terrestrial and marine agencies in Portofino PA (Italy), which resulted in legislation inconsistencies and management gaps, particularly for marine and coastal resources. These isolated country-based assessments commonly overlook important issues for

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the effectiveness of each PA and the entire network, such as the connectivity across the network, which is important for dispersal and movement of individuals (Hermoso et al., 2015; Saura et al., 2019). For this reason, the ecological and physical coherence of the N2K network requires further enhancement (Fig. 2). In particular, work is needed to address connectivity across national boundaries and secure adequate protection across freshwater, terrestrial and marine realms (Giakoumi et al., 2019; Hermoso et al., 2021).

Furthermore, there has also been an asymmetric implementation of the Nature Directives across Member States in both the designation of PAs (Mazaris et al., 2018) and the enforcement of their management plans (EEA, 2020). For example, although the average coverage by terrestrial PAs across the EU is 18.5%, in line with Aichi Target 11 (CBD, 2010), there are large disparities across countries, some well below this target (e.g., Denmark, Latvia, Sweden), while others are well above (Slovenia, Croatia, or Bulgaria, with >30% of their terrestrial area designated as N2K sites). Increasing coverage alone will not, however, ensure successful conservation, as effective management of PAs is often constrained by the lack of adequate management plans to regulate activities and mediate pressures that coexist with biodiversity conservation. By the end of 2018, 30% of Natura 2000 sites were still lacking management plans or equivalent instruments setting out conservation and restoration measures; for the 70% of N2K sites having management plans, these were often not in accordance with the EU standards (EEA, 2020). Levels of enforcement of PAs also vary substantially, often related to resource constraints and/or competing socio-economic pressures (Batista and Cabral, 2016; Fraschetti et al., 2018). There are, therefore, three main pillars that will require attention to improve effectiveness of conservation: i) increased coverage of PAs to fill representation and connectivity gaps, ii) the development of management plans, and iii) improve enforcement across the N2K network (Fig. 2).

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Opportunities: The established N2K network represents an incommensurable opportunity for the management of biodiversity in the next decade. As this network of PAs already covers not only species and habitats of conservation concern listed in the Nature Directives, but also many other co-occurring threatened species, not currently included in these lists (Morán-López et al., 2019), it could be used to extend management to these additional species and habitats (Hermoso et al., 2019a). Management of threatened species and habitats will also benefit from the commitments made in the Biodiversity Strategy for 2030 of extending the network to cover at least 30% of the EU's terrestrial and marine territories, strictly protecting 1/3 of that area, and improving the management of biodiversity both inside and outside PAs (EC, 2020b). The commitment to also improving the coherence, connectivity and resilience of the network, by setting up cross-border ecological corridors would also help overcome some of the weaknesses detailed above (Fig. 2). Additional initiatives, such as the network of Green Infrastructure (EC, 2013) currently under design, could help expand management for biodiversity conservation outside PAs and be an additional tool to address the challenges associated with global change. This network aims to support improved connectivity among PAs through the establishment of ecological corridors, prevent genetic isolation by allowing species migration, and maintain and restore ecosystem services, promoting the design of multi-functional landscapes (EC, 2013). As such, this network of Green Infrastructure could also provide a more hospitable matrix in between PAs, which, in combination with well managed PAs, could enhance the capacity of biodiversity to cope with changes (Hermoso et al., 2020).

Challenges: To be effective, conservation efforts across the EU need to tackle biodiversity conservation under the dynamic conditions imposed by global change (Araujo et al., 2011; Alagador et al., 2014; Rilov et al., 2020). Some studies question the capacity of the current N2K network to withstand the cumulative impacts of climate change and multiple other

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threats, such as land-use change, invasive species, pollution, and overexploitation (Gissi et al., 2021). Creating a more coherent and well-connected network of PAs will strengthen its overall resilience and adaptive capacity to future impacts (Bernhardt and Leslie, 2013).

Moving forward, policy and management will need to be more adaptive to respond to climate change impacts and dynamic conditions (Hermoso et al., 2019b; Vogiatzakis et al., 2020; Fig. 2). For example, in land-locked marine regions constituting hotspots of climate change (e.g., the eastern Mediterranean Sea) current conservation objectives focusing on native species might soon prove unrealistic, as many of those species will go locally extinct or decline despite protection (Rilov, 2016). In such cases, conservation policies should be flexible and adaptive, anticipating scenarios of biodiversity change (Carvalho et al., 2011), and focusing on the conservation of ecosystem functioning, which could be secured by unthreatened or even alien species (Giakoumi et al., 2016; Rilov et al., 2019, 2020).

Another major challenge will be addressing competing interests on land and sea that threaten the expected expansion of the network of PAs (Ertör et al., 2020; Bennett et al., 2021), and the implementation of the Green Infrastructure. There is the risk that the expansion of the network of PAs will be done by designating remote and isolated areas for conservation, regardless of their conservation value, mainly based on their residual commercial value and human activities (e.g., Devillers et al., 2015). In doing so, progress will be made toward the Biodiversity Strategy spatial targets but potentially missing the desired conservation outcomes (Jones and De Santo, 2016).

Integration of conservation into other policies

Strengths: Harmonisation of biodiversity conservation with other human activities is especially relevant in the EU context, since the vast majority of N2K sites allow for “multi-

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uses” including a diverse array of economic and recreational activities within them (Batista and Cabral, 2016; Mazaris et al., 2019). The EU has advanced in legislating and creating mechanisms to embed biodiversity conservation in other sectoral policies. For example, the European Agricultural Fund for Rural Development (EAFRD) gives financial support to agri-environment-climate measures that aim to maintain semi-natural habitats of conservation interest (Lomba et al., 2020). Also, the Common Agriculture Policy (CAP) encourages the designation of High Nature Value Farmland in agricultural land, which provides support for managing grasslands and pastures with traditional non-intensive practices. These measures are beneficial for biodiversity conservation and maintenance of ecosystem services (Bommarco et al., 2013). Similarly, the Common Fisheries Policy aims to regulate potential conflicts between biodiversity conservation and other legitimate uses (e.g., commercial and recreational fishing) by promoting the designation of marine PAs and the implementation of ecosystem-based fisheries management, principally for the maintenance of marine resources and fostering their sustainable exploitation (Fock, 2011).

Weaknesses: Despite progress, there are still considerable negative impacts of human activities reported within N2K sites and substantial conflicts with sectoral policies. Of particular concern is evidence that pressures on biodiversity are at similar levels within and outside N2K sites (Mazaris et al., 2019; Hermoso et al., 2018; Concepción, 2021), often impacting species and habitats for which these PAs were designated (EC, 2020a). Some of these pressures originate from the insufficient enforcement of legislation from other sectors, like agriculture or fisheries, or simply incompatibility between policy objectives. For example, a recent report by the European Court of Auditors (ECA, 2020a) concluded that the mechanisms established in the CAP to benefit biodiversity have not been effective in reversing biodiversity decline in farmlands. Similarly, most marine populations in European seas continue to decline and this is in part attributed to the lack of enforcement of the

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Common Fisheries Policy at Member States' fisheries authority level (Da Rocha et al., 2012).

This poor integration of conservation into other sectoral policies is also evident from a financial point of view (see the Funding section below) and highlights the need for further work in the future.

Opportunities: The new biodiversity conservation policy context in the EU, led by the Green Deal and Biodiversity Strategy for 2030, facilitates opportunities to foster further integration of biodiversity conservation into other sectoral policies with special attention for management outside PAs. For example, there is a clear commitment to “bringing nature back to agricultural land” by promoting more sustainable farming under the new Biodiversity Strategy (EC, 2020b). This also involves the new Farm to Fork Strategy and the new CAP, which should foster the implementation of more sustainable agricultural practices (Lomba et al., 2020). Additional measures that could help integrate biodiversity conservation with other sectors include the support of CAP Strategic Plans, and the Cohesion Policy funds to afforestation, reforestation, and tree planting to support biodiversity and ecosystem restoration (Moreira and Pe´er, 2018). In the marine environment, the integration of conservation with other sectors can be achieved by developing spatially optimized national maritime spatial plans, focusing on biodiversity conservation while also maximizing exploitation of maritime resources and activities, as provisioned by the Maritime Spatial Planning Framework Directive (Markantonatou et al, 2021). Furthermore, the identification of “other effective area-based conservation measures” (OECMs), as promoted by IUCN and the Biodiversity Strategy, can contribute to integrating conservation in other sectoral policies such as the Common Fisheries Policy to reach the Biodiversity Strategy targets by exploiting, for example, the potential of Fisheries Restricted Areas to provide conservation benefits (Petza et al., 2019; Fig. 2). Co-location of different economic activities (e.g., windfarms and fisheries) could help make a more efficient use of space and reduce potential conservation

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conflicts (Yates et al., 2015). The EU's 2030 and 2050 climate and energy objectives laid out in the European Green Deal stressed the relative importance of offshore renewable energy in the North Sea and led to the North Seas Energy Cooperation. This can lead to an improved coordination of maritime spatial planning and to the development of a common framework for assessing environmental impacts (EC, 2020c; Fig. 2).

Challenges: The biodiversity conservation and restoration objectives of the Biodiversity Strategy for 2030 may face incompatibilities and conflicts with other policies. For example, the post-2020 CAP continues supporting subsidies through area-based 'Direct Payments' that can lead to intensification of agricultural activities with low levels of environmental requirements and often negative impacts on biodiversity (Pe'er et al., 2020). In marine areas, the Blue Growth and its inherent notion of sustainability may provide new conservation opportunities, but it may also jeopardise conservation efforts through a slippery slope of compromises if not adequately addressed (Katsanevakis et al., 2020). Under the current unfavourable status of European ecosystems and continuing biodiversity loss in the oceans, it is reasonable to wonder if economic growth is compatible with the conservation targets of the Biodiversity Strategy. A challenge, therefore, remains from past weaknesses to ensure that future development does not come at the expense of compromising conservation efforts and effectiveness of PAs (Fig. 2).

Governance and stakeholder participation

Strengths: Governance concerns the interface between legality (established in policies and laws) and legitimacy (broadly accepted in society). Collaborative and multilevel governance approaches that incorporate a variety of stakeholders, including the general public, in conservation strategies and policies are arguably essential for successful PA management (Dimitrakopoulos et al., 2010; Apostolopoulou et al., 2012; Yates, 2018). The importance of

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stakeholder participation is recognised within EU legislation: the Habitats Directive refers to the need for local community involvement in the establishment of the PAs, although not compulsory, and the Aarhus Convention entitles the public to access environmental information and take part in environmental decision-making (UNECE, 1998). There are many examples where the involvement of stakeholders has been important to site identification, designation and management (EC, 2002; Rauschmayer et al., 2009). Even though stakeholder participation poses challenges and does not guarantee success, it has many proven beneficial conservation outcomes such as i) greater and more diverse data collection which leads to a more holistic understanding of the context and management challenges, ii) increased trust and collaboration among actors, both of which have the substantial potential to improve the decision-making processes and compliance (Yates et al., 2019), and iii) reduced public opposition and minimization of negative socio-economic impacts promoting long-term sustainable management (Dimitrakopoulos et al., 2010; Hogg et al., 2016).

Weaknesses: Governance of N2K sites and the participation of stakeholders and the wider public remains an area of conflict, however, with many groups feeling failed by current systems (Apostolopoulou et al., 2012; Yates, 2014). As the N2K network has expanded across Europe, tensions with landowners and users of public land have grown (Blondet et al., 2017). Local authorities and communities living in and around PAs often report mixed attitudes about the designation of N2K sites (Dimitrakopoulos et al., 2010) and different stakeholders often have divergent priorities and opinions on how PAs should be managed (e.g., Mangi and Austen, 2008; Brescancin et al., 2018). Even though the N2K network can provide a framework for a collaborative approach to environmental governance that could bring those different attitudes and priorities together, many times a top-down or “black-box” approach has been followed without meaningful involvement of stakeholders (Manolache et

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al., 2018, Pecceu et al., 2016). Whilst enabling meaningful and ongoing participation is challenging and resource consuming, failure to do so is considered one of the main drivers of conflicts (McGuinn et al., 2017; Jones et al., 2020). Issues often arise from misinformation or lack of information about what is protected, why, and where in N2K sites, coupled with mistrust in central governments (Pecceu et al., 2016). Ongoing low levels of participation in the designation and management of the N2K network coupled with an insufficient consideration of the local context weaken the effective functioning of the network (Blicharska et al., 2016; Jones et al., 2020). This can cause a local perception that PAs are more a threat than an opportunity (Hattam et al., 2014). Addressing this weakness and ensuring adequate consideration of local values, interests and needs is critical, not only to biodiversity conservation, but also to social equity (Jones et al., 2020) and, the long-term sustainability of the network.

Opportunities: The Biodiversity Strategy for 2030 aims to set a new governance framework to “ensure co-responsibility and co-ownership by all relevant actors in meeting the EU’s biodiversity commitments” (EC, 2020b). This new framework will support administrative capacity building, transparency, stakeholder dialogue, and participatory governance at different levels. Public participation in PA management is an opportunity to grow environmental stewardship and lead individuals and communities to protect, care for or responsibly use the environment in pursuit of environmental and/or social outcomes (Bennett et al., 2018). Participation that might start with simple information provision could lead to lifelong passions and empowered individuals and communities that make a real difference to their local environments and livelihoods (Toomey and Domroese, 2013). Besides increasing environmental knowledge and stewardship, well-designed citizen science programmes can also contribute substantially to data collection and improved understanding of the status of the environment (Lye et al., 2012; Fraisl et al., 2020). There is also the opportunity to

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enhance communication between stakeholders, including the general public, through existing formal and informal stakeholder structures, such as voluntary coastal partnerships, which are a well-established informal method for enabling stakeholder participation in coastal management in the UK (Buchan and Yates, 2019; Fig. 2).

Challenges: Part of realising the commitment to make conservation about people will have to involve enhancing how all stakeholders, including the general public, can engage with PA management. Arguably, the first stage to enable engagement is by providing access to information on existing and proposed PA management activities. Challenges remain around sustainable, long-term resourcing of websites and other means of communication (Buchan and Yates, 2019). Even when efforts are made to provide information, there are challenges in making it accessible and much more progress is needed to improve effective knowledge exchange (De Santo, 2016), particularly between sectors, and securing long-term funding for roles with intangible outcomes (Dickinson et al., 2012; Fig. 2).

However, the greatest challenge for governmental institutions will be to shift their roles from simple decision-making to mediation, coordination, collective learning and empowerment of communities towards social and ecological resilience (Bodin, 2017; Plummer et al., 2017).

Multiple models of co-management of PAs are emerging, such as the Inshore Fisheries and Conservation Authorities in England (Pieraccini and Cardwell, 2015). There are also examples of effective participatory approaches in PAs management, such as in the Menorca Biosphere Reserve (Synge, 2004). These examples demonstrated how multiple stakeholders can be successfully brought together to make collective decisions on PA management (Fig. 2). Enabling sustainable co-management presents the further challenge of overcoming unequal distribution of benefits derived from new economic opportunities in PAs (Oikonomou and Dikou, 2008), as well as minimising impacts on traditional activities and sources of income that hinders social equity in local communities (Jones et al., 2020). For

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example, income derived from tourism does not always benefit local populations

(Oikonomou and Dikou, 2008), while restrictions or complexity of bureaucratic procedures could threaten mainly local culture and socio-economic activities (Rees et al., 2013). Thus, the challenge for PA governance and management is to progress from its origins based only in biodiversity conservation to embrace socio-ecological systems (Fig. 2).

Funding

Strengths: Within the EU, common funding mechanisms for biodiversity conservation have been established at a continental scale, either specifically devised for conservation purposes or embedded in other sectoral policies. For example, Prioritised Action Frameworks (PAFs) were adopted to strengthen coordination and integration of financing for biodiversity. PAFs comprise a tool to identify N2K conservation priorities at national or regional scales and the different funding sources within the context of the relevant EU financial instruments available to support their accomplishment (Kettunen et al., 2017). Within the different sources of funding for biodiversity conservation, the LIFE Program represents the most direct source of funding, specifically designed to cover the implementation of management of biodiversity (mainly within PAs) and has become the main financial instrument for direct conservation in the EU (Hermoso et al., 2017). To complement direct funding allocation, there are multiple additional funding mechanisms associated with other policies, such as the European Agricultural Fund for Rural Development (EAFRD), through agri-environment-climate measures (Lomba et al., 2020), the European Maritime and Fisheries Fund (EMFF), the European Regional Development Fund (ERDF), the Natural Capital Financing Facility (NCFE), or the Horizon 2020 Programme. These funding sources can lead to further integration of biodiversity conservation into other sectors (see Integration of conservation into other policies section above).

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Weaknesses: Currently, financial resources for biodiversity conservation are insufficient.

Kettunen et al. (2011) estimated that the financial allocations for N2K from the EU budget were between €550 – €1150 million annually in the period 2007-2013, which only represented between 9-19 % of the financing needs. The distribution of available funds for conservation also needs to be more effective and transparent to overcome biases towards charismatic (but not necessarily threatened), species (Kettunen et al., 2009; Mammola et al., 2020), while many species at risk of extinction are omitted (Hermoso et al., 2017; Christodoulou et al. 2018; Giakoumi et al. 2019). Moreover, the distribution of funds should be rationalized to incorporate the heterogeneous distribution of threatened species and habitats across the EU (Hermoso et al., 2017).

Accurate estimates of funding needs are urgently needed. The costs of preserving and managing the N2K network through PAFs were unrealistically estimated (ECA, 2017). Moreover, often funding opportunities are not specifically attributed to biodiversity conservation measures and the management of the N2K network (Kettunen et al, 2009). For instance, up to 90% of funds for biodiversity conservation are related to the European Agricultural Fund for Rural Development program or the European Regional Development Fund sources. These funds have previously been used to support actions that are not necessarily beneficial for biodiversity (e.g., infrastructure investments under the European Regional Development Fund) or have even caused more biodiversity harm than good (Kettunen et al., 2011). For example, intensive farming remains a main cause of biodiversity loss in farmlands despite a total of €66 billion that have been allocated to halt biodiversity decline on farms across Europe, between 2014 and 2021 (ECA, 2020). There is also an insufficient exploration of the effectiveness of past financing in biodiversity conservation, as investment from some of these funding sources is difficult to track (Kettunen et al., 2011). Insufficient budgets also constrain the capacity to monitor the responses of biodiversity to

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changing threats and the effectiveness of management efforts (Sini et al., 2017) which, in turn, limits the opportunity to learn and adapt (Rilov et al., 2020; Garcia-Baron et al., 2021).

Opportunities: The Biodiversity Strategy for 2030 brings novel funding opportunities to support biodiversity conservation and the restoration of degraded habitats. It acknowledges the important contribution that biodiversity makes to our economy and wellbeing, and the need to “ensure that the economy serves people and society and gives back to nature more than it takes away” with at least 20 billion €/ year unlocked for spending on nature (EC, 2020b). This financial support will come from public investment and the private sector, fostering the contribution of industry and business to help address biodiversity loss. The European Commission will look for funding opportunities through the promotion of the European Business for Biodiversity movement (e.g., by incentivising the implementation of nature-based solutions, as a source of the green economy), or promoting tax systems and pricing that reflect environmental costs. Additional mechanisms to source funding for biodiversity conservation have also been proposed in the Biodiversity Strategy (e.g., Payment for Ecosystem Services), but still need policy development that would regulate their application. Funding opportunities associated with the recovery from the COVID-19 pandemic will also arise. For example, an important portion of the investment planned under the NextGenerationEU Recovery Plan and multi-annual budget (2021-2027) that aims to help overcome the impacts of the global pandemic will support the implementation of the EU Green Deal (EC, 2019).

Challenges: There is uncertainty on whether these funding commitments will be enough to cover the ambitious goals pursued by the new Biodiversity Strategy. Given the deep funding gap already existing to manage the current network of PAs (Kettunen et al., 2017), questions arise on how to secure adequate funding for the established N2K network and the significant expansion planned. The expansion of the N2K network without the corresponding financial

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support raises the risk of not achieving the new Biodiversity Strategy's objectives and threatens to weaken the effectiveness of ongoing management plans (Gill et al., 2017).

An additional challenge of the new funding context set by the Biodiversity Strategy for 2030 is the assurance that financial support from the private sector does not come at a high environmental and ecological cost (Fig. 2). For example, the development of green sources of energy (hydropower, wind and solar) promoted by the European Green Deal could pose an additional burden to biodiversity conservation, if inadequately planned, threatening important areas for conservation within and outside PAs (Kiesecker et al., 2019; Kati et al., 2021).

Furthermore, the pandemic crisis is still a major concern that can impact funding priorities in the near future. National governments, in their attempt to deal with the global economic recession, are likely to reduce funds dedicated to biodiversity conservation and related research (Corlett et al. 2020), while prioritizing funds to meet the urgent needs in healthcare and economic recovery.

Conclusions

The success of the new EU Biodiversity Strategy in achieving its ambitious objectives will depend on the capacity of the EU Member States to plan strategically the implementation of conservation measures under limited and uncertain budgets, better engage with the general public, and avoid or solve potential conflicts with other socio-economic objectives and different sectoral policies (Fig. 2). All these actions will have to be optimized while recovering from the negative social and economic effects of the COVID-19 pandemic. A key step for an efficient implementation of the Biodiversity Strategy for 2030 should start by recognising the strengths and weaknesses of past biodiversity management experience, identifying gaps and capitalising on previous efforts. Adequate planning can help overcome part of the common past weaknesses of EU's policy, such as the insufficient representativity

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and connectivity of the N2K network (e.g., Mazaris et al., 2018), inadequate distribution of limited conservation funds (Hermoso et al., 2018), or conflicts between biodiversity conservation and other interests (Katsanevakis et al. 2015).

Global change and the dynamic conditions derived from it pose major challenges to biodiversity management (Rilov et al., 2020). To be effective, management for biodiversity conservation needs to be adaptive to respond to those dynamic conditions. In some cases, management outside PAs will be necessary to make conservation efforts more effective and robust to global change. There are policy and funding mechanisms to support the management of biodiversity outside PAs, such as the designation of the future network of Green Infrastructure or new High Nature Value Farming in agricultural land (Fig. 2).

However, as past experience shows, the implementation of these strategies will require careful planning to minimise potential conflicts between biodiversity conservation and other sectoral interests. A better integration of biodiversity conservation into other sectoral policies and funding mechanisms will be key to overcome past failures.

Common goals need common efforts, not only financially, but also from governance and multi-sector integration points of view. Without these, future implementation of the EU nature policy will be prone to fall into past mistakes and failures. Some of these needs are not specifically addressed in current policy, so they deserve urgent attention to lead Europe towards the desired recovery of biodiversity and more sustainable development. This could also strengthen the role of the EU as a world leader in biodiversity conservation by showing the pathway towards halting biodiversity loss in other regions in the world, needed under the global biodiversity crisis. This strong leadership is key for the development of the international agenda during the coming decades, with new international agreements, such as the new Convention on Biological Diversity, to be negotiated and implemented and, ultimately, halting biodiversity loss.

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References

- Alagador, D., Cerdeira, J.O., Araújo, M.B. (2014). Shifting protected areas: scheduling spatial priorities under climate change. *Journal of Applied Ecology*, 51, 703–713.
- Apostolopoulou, E., Drakou, E.G., Padiaditi, K. (2012). Participation in the management of Greek Natura 2000 sites: Evidence from a cross-level analysis. *Journal of Environmental Management*, 113, 308-318.
- Araújo, M.B., Alagador, D., Cabeza, M., Nogués-Bravo, D., Thuiller, W. (2011). Climate change threatens European conservation areas. *Ecology Letters*, 14, 484–492.
- Batista, M.I., Cabral, H.N. (2016). An overview of Marine Protected Areas in SW Europe: Factors contributing to their management effectiveness. *Ocean and Coastal Management*, 132, 15-23.
- Bennett, N. J., Blythe, J., White, C. S., Campero, C. (2021). Blue growth and blue justice: Ten risks and solutions for the ocean economy. *Marine Policy*, 125, 104387.
- Bennett, N.J., Whitty, T.S., Finkbeiner, E., Pittman, J., Bassett, H., Gelcich, S., Allison, E.H. (2018). Environmental Stewardship: A Conceptual Review and Analytical Framework. *Environmental Management*, 61, 597–614.
- Bernhardt, J.R., Leslie, H.M. (2013). Resilience to Climate Change in Coastal Marine Ecosystems. *Annual Review of Marine Science*, 5, 371-392.
- Blicharska, M. et al., 2016. Contribution of social science to large scale biodiversity conservation: A review of research about the Natura 2000 network. *Biological Conservation*, 199, 110–122
- Blondet, M., de Koning, J., Borrass, L., Ferranti, F., Geitzenauer, M., Weiss, G., Turnhout, E. and Winkel, G. (2017). Participation in the implementation of Natura 2000: A comparative study of six EU member states. *Land Use Policy*, 66, 346-355.
- Bodin, O. (2017). Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science*, 357, 659.
- Bommarco, R., Kleijn, D., Potts, S.G. (2013). Ecological intensification: harnessing ecosystem services for food security. *Trends in Ecology and Evolution*, 28, 230–238.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Brescancin, F., Dobšinská, Z., DeMeo, I., Šálka, J., Paletto, A. (2018). Analysis of stakeholders' involvement in the implementation of the Natura 2000 network in Slovakia. *Forest Policy and Economics*, 89, 22-30.
- Buchan, P.M., Yates, K.L. (2019). Stakeholder dynamics, perceptions and representation in a regional coastal partnership. *Marine Policy*, 101, 125-136.
- Campagnaro, T., Sitzia, T., Bridgewater, P., Evans, D., Ellis, E.C. (2019). Half Earth or Whole Earth: What Can Natura 2000 Teach Us? *BioScience*, 69, 117-124.
- Carvalho, S.B., Brito, J.C., Crespo, E.G., Watts, M.E., Possingham, H.P. (2011). Conservation planning under climate change: Toward accounting for uncertainty in predicted species distributions to increase confidence in conservation investments in space and time. *Biological Conservation*, 144, 2020–2030.
- CBD (2010). The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets". UNEP/CBD/COP/DEC/X/2.
- Christodoulou, C.S., Griffiths, G.H., Vogiatzakis, I.N. (2018). Using threatened plant species to identify conservation gaps and opportunities on the island of Cyprus. *Biodiversity and Conservation*, 27, 2837-2858.
- Concepción, E.D. (2021). Urban sprawl into Natura 2000 network over Europe. *Conservation Biology*, 35, 1063-1072.
- Corlett, R. T., Primack, R. B., Devictor, V., Maas, B., Goswami, V. R., Bates, A. E., Pin Koh, L., Regan, T.J., Loyola, R., Pakeman, R., Cumming, G.S., Pidgeon, A., Johns, D. & Roth, R. (2020). Impacts of the coronavirus pandemic on biodiversity conservation. *Biological conservation*, 246, 108571.
- Da Rocha, J.M., Cerviño, S., Villasante, S. (2012). The common fisheries policy: an enforcement problem. *Marine Policy*, 36, 1309-1314.
- De Santo, E.M. (2016). Assessing public “participation” in environmental decision-making: Lessons learned from the UK Marine Conservation Zone (MCZ) site selection process. *Marine Policy*, 64, 91-101.
- Devillers, R., Pressey, R. L. , Grech, A. , Kittinger, J. N., Edgar, G. J., Ward, T., Watson, R. (2015). Reinventing residual reserves in the sea: are we favouring ease of establishment over need for protection? *Aquatic Conservation: Marine and Freshwater Ecosystems*, 25, 480-504.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Dickinson, J.L., Shirk, J., Bonter, D., Bonney, R., Crain, R.L., Martin, J., Phillips, T., Purcell, K. (2012). *Frontiers in Ecology and the Environment*, 10, 291-297.
- Dimitrakopoulos, P.G., Jones, N., Iosifides, T., Florokapi, I., Lasda, O., Paliouras, F., Evangelinos, K.I. (2010). Local attitudes on protected areas: Evidence from three Natura 2000 wetland sites in Greece. *Journal of Environmental Management*, 91, 1847-1854.
- EC (2002). El Teide Declaration. European Commission, Brussels.
- EC (2011). Our life insurance, our natural capital: an EU biodiversity strategy to 2020.
- EC (2013). Green Infrastructure (GI) — Enhancing Europe’s Natural Capital. SWD(2013) 155 final.
- EC (2019). The European Green Deal. Brussels, 11.12.2019 COM(2019) 640 final.
- EC (2020a). The state of nature in the European Union. Report on the status and trends in 2013 - 2018 of species and habitat types protected by the Birds and Habitats Directives. Brussels, 15.10.2020 COM(2020) 635 final.
- EC (2020b). EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Brussels, 20.5.2020 COM(2020) 380 final.
- EC (2020c). An EU Strategy to harness the potential of offshore renewable energy for a climate neutral future. Brussels, 19.11.2020 COM(2020)741 final.
- ECA (2020a). ECA special report 13/2020. Biodiversity on farmland: CAP contribution has not halted the decline.
- ECA (2020b), Biodiversity on Farmland: CAP Contribution has not Halted the Decline, Special Report N°13/2020, European Court of Auditors, Luxembourg.
- Ertör, I., Hadjimichael, M. (2020). Blue degrowth and the politics of the sea: rethinking the blue economy. *Sustainability Science*, 15, 1-10.
- ECA (2017). More efforts needed to implement the Natura 2000 network to its full potential (pursuant to Article 287(4), second subparagraph, TFEU). Special Report. Publications Office of the European Union, Luxembourg. 64pp.
- EEA (2020) Management effectiveness in the EU’s Natura 2000 network of protected areas. Prepared for the EEA by The Institute for European Environment Policy (IEEP), UNEP-WCMC and Trinomics. 87pp.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Evans, D. 2012. Building the European Union's Natura 2000 network. *Nature Conservation*, 1: 11–26.
- Fock, H.O. (2011). Natura 2000 and the European Common Fisheries Policy. *Marine Policy*, 35, 181-188.
- Fraisl, D., Campbell, J., See, L., When, U., Wardlaw, J., Gold, M., Moorthy, I., Arias, R., Piera, J., Oliver, J.L., Masó, J., Penker, M., Fritz, S. (2020). Mapping citizen science contributions to the UN sustainable development goals. *Sustainability Science*, 15, 1735–1751.
- Fraschetti, S., Pipitone, C., Mazaris, A.D., Rilov, G., Badalamenti, F., Bevilacqua, S., Claudet, J., Caric, H., Dahl, K., D'Anna, G., Daunys, D., Frost, M., Gissi, E., Göke, C., Goriup, P., Guarnieri, G., Holcer, D., Lazar, B., Mackelworth, P., Manzo, S., Martin, G., Palialexis, A., Panayotova, M., Petza, D., Rumes, B., Todorova, V., Katsanevakis, S. (2018). Light and shade in marine conservation across European and contiguous seas. *Frontiers in Marine Science*, 5, 420.
- García-Barón, I., Giakoumi, S., Santos, M. B., Granado, I., & Louzao, M. (2021). The value of time-series data for conservation planning. *Journal of Applied Ecology*, 58(3), 608-619.
- Giakoumi, S, Hermoso, V, Carvalho, S, Markantonatou, V, Dagys, M, Iwamura, T, Probst, W, Smith, R, Yates, KL, Almpanidou, V, Novak, T, Ben-Moshe, N, Katsanevakis, S, Claudet, J, Coll, M, Deidun, A, Essl, F, Garcia-Charton, JA, Jimenez, C, Kark, S, Mandić, M, Mazaris, A, Rabitsch, W, Stelzenmüller, V, Tricarico, E and Vogiatzakis, I (2019). Conserving European biodiversity across realms. *Conservation Letters*, 12, e12586.
- Giakoumi, S., Guilhaumon, F., Kark, S., Terlizzi, A., Claudet, J., Felling, S., Cerrano, C., Coll, M., Danovaro, R., Frascchetti, S., Koutsoubas, D., Ledoux, J.B., Mazon, T., Mérigot, B., Micheli, F., Katsanevakis, S. (2016). Space invaders; biological invasions in marine conservation planning. *Diversity and Distributions*, 22, 1220-1231.
- Gill, D.A., Mascia, M.B., Ahmadi, G.N., Glew, L., Lester, S.E., Barnes, M., Craigie, I., Darling, E.S., Free, C.M., Geldmann, J., Holst, S., Jensen, O.P., White, A.T., Basurto, X., Coad, L., Gates, R.D., Guannel, G., Mumby, P.J., Thomas, H., Whitmee, S., Woodley, S., Fox, H.E. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543, 665-669.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Gissi, E., Manea, E., Mazaris, A.D., Frascchetti, S., Almpandou, V., Bevilacqua, S., Coll, M., Guarnieri, G., Pascual, M., Petza, D., Rilov, G., Schonwald, M., Stelzenmüller, V., Katsanevakis, S. (2021). A review of the combined effects of climate change and other human stressors on the marine environment. *Science of the Total Environment*, 755, 142564.
- Guidetti, P., Milazzo, M., Bussotti, S., Molinari, A., Murenu, M., Pais, A., Spano, N., Balzano, R., Agardy, T., Boero, F., Carrada, G. (2008). Italian marine reserve effectiveness: does enforcement matter? *Biological Conservation*, 141, 699-709.
- Hattam, C.E., Mangi, S.C., Gall, S.C., Rodwell, L.D., 2014. Social impacts of a temperate fisheries closure: understanding stakeholders' views. *Marine Policy*, 45, 269–278.
- Hermoso, V., Clavero, M., Villero, D, Brotons, Ll. (2017). EU's conservation efforts need more strategic investment to meet continental commitments. *Conservation Letters*, 10, 231-237.
- Hermoso, V., Filipe, A.F., Segurado, P., Beja, P. (2015). Effectiveness of a large reserve network in protecting freshwater biodiversity: a test for the Iberian Peninsula. *Freshwater Biology*, 60, 698-710.
- Hermoso, V., Morán-Ordóñez, A., Brotons, Ll. (2018). Assessing the role of Natura 2000 at maintaining dynamic landscapes in Europe over the last two decades: implications for conservation. *Landscape Ecology*, 33, 1447–1460.
- Hermoso, V., Morán-Ordóñez, A., Canessa, S., Brotons, Ll. (2019a). Realising the potential of Natura 2000 to achieve EU conservation goals as 2020 approaches. *Scientific Reports*, 9, 16087.
- Hermoso, V., Morán-Ordóñez, A., Lanzas, M., Brotons, Ll. (2020). Designing a network of Green Infrastructure for the EU. *Landscape and Urban Planning*, 196, 103732.
- Hermoso, V., Vasconcelos, R.P., Henriques, S., Filipe, A.F., Carvalho, S.B. (2021). Conservation planning across realms: enhancing connectivity for multi-realm species. *Journal of Applied Ecology*, 58, 644-654.
- Hermoso, V., Morán-Ordóñez, A., Canessa, S., Brotons, Ll. (2019b). A dynamic strategy for EU conservation. *Science*, 363: 592-593.

Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.

Hogg, K., Markantonatou, V., Noguera-Méndez, P., Semitiel-García, M. (2016). Incentives for good governance: getting the balance right for Port Cros National Park (Mediterranean Sea, France). *Scientific Reports Port-Cros National Park*, 30, 165-178.

IPBES (2019). Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Available at: <https://www.ipbes.net/news/ipbes-global-assessment-summary-policymakers-pdf> (last visited May 30th, 2019).

Jones, P.J., De Santo, E. (2016). Is the race for remote, very large marine protected areas (VLMPPAs) taking us down the wrong track? *Marine Policy*, 73, 231-234.

Jones, N., Graziano, M., Dimitrakopoulos, P.G. (2020). Social impacts of European Protected Areas and policy recommendations. *Environmental Science and Policy*, 112, 134–140.

Kati, V., Kassara, C., Vrontisi, Z., Moustakas, A. (2021). The biodiversity-wind energy-land use nexus in a global biodiversity hotspot. *Science of The Total Environment*, 768. 144471.

Katsanevakis, S., Levin, N., Coll, M., Giakoumi, S., Shkedi, D., Mackelworth, P., Levy, R., Velegrakis, A., Koutsoubas, D., Caric, H., Brokovich, E., Öztürk, B., Kark, S. (2015). Marine conservation challenges in an era of economic crisis and geopolitical instability: The Mediterranean Sea case. *Marine Policy*, 51, 31–39.

Katsanevakis, S., Coll, M., Frascetti, S., Giakoumi, S., Goldsborough, D., Mačić, V., Mackelworth, P.C., Rilov, G., Stelzenmüller, V., Albano, P.G., Bates, A.E., Bevilacqua, S., Gissi, E., Hermoso, V., Mazaris, A.D., Pita, C., Rossi, V., Teff-Seker, Y., Yates, K. (2020). Twelve recommendations for advancing marine conservation in European and contiguous seas. *Frontiers in Marine Science*, 7, 565968.

Kettunen, M., Baldock, D., Adelle, C., Cooper, T., Farmer, M., Hart, K., Torkler, P. (2009). Biodiversity and the EU budget. Making the case for conserving biodiversity in the context of the EU Budget Review. WWF, Brussels, Belgium. (Available at: https://www.wwf.gr/images/pdfs/WWF_Biodiversity%20and%20EU%20budget.pdf; last visited April 4, 2017).

Kettunen, M., Baldock, D., Gantioler, S., Baldock, D., Torkler, P., Arroyo Schnell, A., Baumüller, A., Gerritsen, E., Rayment, M., Daly, E., Pieterse M. (2011). Assessment of the Natura 2000 co-financing arrangements of the EU financing instrument. A project for

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- the European Commission – final report. Institute of European Environmental Policy, Brussels, Belgium. (Available at http://ec.europa.eu/environment/enveco/biodiversity/pdf/assessment_natura2000.pdf; last visited April 5, 2017).
- Kettunen, M., Illes, A., Rayment, M., Primmer, E., Verstraeten, Y., Rekola, A., Ring, I., Tucker, G., Baldock, D., Droste, N., Santos, R., Rantala, S., Ebrahim, N., ten Brink, P. (2017). Integration approach to EU biodiversity financing: evaluation of results and analysis of options for the future. Final report for the European Commission (DG ENV) (Project ENV.B.3/ETU/2015/0014), Institute for European Policy (IEEP), Brussels / London
- Kiesecker, J., Baruch-Mordo, S., Kennedy, C.M., Oakleaf, J.R., Baccini, A., Griscom, B.W. (2019). Hitting the Target but Missing the Mark: Unintended Environmental Consequences of the Paris Climate Agreement. *Frontiers in Environmental Science*, 7, 151.
- Lomba, A., Moreira, F., Klimek, S., Jongman, R. H., Sullivan, C., Moran, J., Poux, X., Honrado, J.P., Pinto-Correia, T., Plieninger, T., McCracken, D. I. (2020). Back to the future: rethinking socioecological systems underlying high nature value farmlands. *Frontiers in Ecology and the Environment*, 18, 36-42.
- Lye, G.C., Osborne, J.L., Park, K.J., Goulson, D. (2012). Using citizen science to monitor *Bombus* populations in the UK: nesting ecology and relative abundance in the urban environment. *Journal of Insect Conservation*, 16, 697–707.
- Maiorano, L., Amori, G., Boitani, L. (2015). On how biodiversity is covered in Europe by national protected areas and by the Natura 2000 network: insights from terrestrial vertebrates. *Conservation Biology*, 29, 986–995.
- Mammola, S., Riccardi, N., Prié, V., Correia, R., Cardoso, P., Lopes-Lima, M., Sousa, R. (2020). Towards a taxonomically unbiased European Union biodiversity strategy for 2030. *Proceedings of the Royal Society, Biological Sciences*, 287, 20202166.
- Mangi, S.C., Austen, M.C. (2008). Perceptions of stakeholders towards objectives and zoning of marine-protected areas in southern Europe. *Journal for Nature Conservation*, 16, 271-280.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Manolache, S., Nita, A., Ciocanea, C.M., Popescu, V.D., Rozyłowicz, L. (2018). Power, influence and structure in Natura 2000 governance networks. A comparative analysis of two protected areas in Romania. *Journal of Environmental Management*, 212, 54-64.
- Markantonatou, V., Noguera-Méndez, P., Semitiel-García, M., Hogg, K., Sano, M. (2016). Social networks and information flow: Building the ground for collaborative marine conservation planning in Portofino Marine Protected Area (MPA). *Ocean & Coastal Management*, 120, 29-38.
- Markantonatou, V., Giakoumi, S., Koukourouvli, N., Maina, I., Gonzalez-Mirelis, G., Sini, M., Maistrelis, K., Stithou, M., Gadoglou, E., Petza, D., Kavadas, S., Vassilipoulou, V., Buhl-Mortensen, L., Katsanevakis, S. (2021). Marine spatial plans focusing on biodiversity conservation: The case of the Aegean Sea. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 120, 29-38.
- Mazaris, A. D., Alpanidou, V., Giakoumi, S., Katsanevakis, S. (2018). Gaps and challenges of the European network of protected sites in the marine realm. *ICES Journal of Marine Science*, 75, 190-198.
- Mazaris, A.D., Kallimanis, A., Gissi, E., Pipitone, C., Danovaro, R., Claudet, J., Rilov, G., Badalamenti, F., Stelzenmüller, V., Thiault, L., Benedetti-Cecchi, L., Goriup, P., Katsanevakis, S., Fraschetti, S. (2019). Threats to marine biodiversity in European protected areas. *Science of the Total Environment*, 677, 418–426.
- McGuinn, J., Oulès, L., Bradley, H., McNeill, A. (2017). Effective multi-level environmental governance for a better implementation of EU environment legislation. European. European Union and the Committee of the Regions, 88 pp.
- Milieu, IEEP, ICF. (2016). Evaluation study to support the fitness check of the Birds and Habitats Directives. Brussels, 668 pp.
- Morán-López, R., Cortés Gañán, E., Uceda Tolosa, O., & Sánchez Guzmán, J. M. (2019). The umbrella effect of Natura 2000 annex species spreads over multiple taxonomic groups, conservation attributes and organizational levels. *Animal Conservation*, 23, 407-419.
- Moreira, F., Pe'er, G. (2018). Agricultural policy can reduce wildfires. *Science*, 359, 1001.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Oikonomou, Z.S., Dikou, A. (2008). Integrating conservation and development at the national marine park of alonissos, northern sporades, Greece: perception and practice. *Environ. Manage.* 42, 847–866.
- Pecceu, E., Hostens, K., Maes, F. (2016). Governance analysis of MPAs in the Belgian part of the North Sea. *Marine Policy*, 71, 265-274.
- Pe'er, G., Bonn, A., Bruelheide, H., Dieker, P., Eisenhauer, N., Feindt, P.H., Hagedorn, G., Hansjürgens, B., Herzon, I., Lomba, A., Marquard, E., Moreira, F., Nitsch, H., Oppermann, R., Perino, A., Röder, N., Schleyer, C., Schindler, S., Wolf, C., Zinngrebe, Y., Lakner, S. (2020). Action needed for the EU Common Agricultural Policy to address sustainability challenges. *People and Nature*, 2, 305–316.
- Petza, D., Chalkias, C., Koukourouvli, N., Coll, M., Vassilopoulou, V., Karachle, P., Markantonatou, V., Tsikliras, A., Katsanevakis, S. (2019). An operational framework to assess the value of fisheries restricted areas for marine conservation. *Marine Policy*, 102, 28–39.
- Pieraccini, M., Cardwell, E. (2015). Towards deliberative and pragmatic co-management: a comparison between inshore fisheries authorities in England and Scotland. *Environmental Politics*, 25, 729-748.
- Plummer, R., Dzyundzyak, A., Baird, J., Bodin, O.È., Armitage, D., Schultz, L. (2017), How do environmental governance processes shape evaluation of outcomes by stakeholders? A causal pathways approach. *PLoS ONE*, 12, e0185375.
- Rauschmayer, F., van den Hove, S., Koetz, T. (2009). Participation in EU biodiversity governance: how far beyond rhetoric? *Environment and Planning C: Government and Policy*, 27, 42–58.
- Rees, S.E., Rodwell, L.D., Searle, S., Bell, A. (2013). Identifying the issues and options for managing the social impacts of Marine Protected Areas on a small fishing community. *Fish. Res.* 146, 51–58.
- Rilov, G., Mazaris, A., Stelzenmüller, V., Helmuth, B., Wahl, M., Guy-Haim, T., Mieszkowska, N., Ledoux, J.P., Katsanevakis, S. (2019). Adaptive marine conservation planning in the face of climate change: What can we learn from physiological, genetic and ecological studies? *Global Ecology and Conservation*, 17, e00566.

- Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.
- Rilov, G. (2016). Multi-species collapses at the warm edge of a warming sea. *Scientific Reports*, 6, 36897.
- Rilov, G., Frascetti, S., Gissi, E., Pipitone, C., Badalamenti, F., Tamburello, L., Menini, E., Goriup, P., Mazaris, A.D., Garrabou, J., Benedetti-Cecchi, L., Danovaro, R., Loiseau, C., Claudet, J., Katsanevakis, S. (2020). A fast-moving target: achieving marine conservation goals under shifting climate and policies. *Ecological Applications*, 30, e02009.
- Saura, S., Bertzky, B., Bastin, L., Battistella, L., Mandrici, A., Dubois, G. (2019). Global trends in protected area connectivity from 2010 to 2018. *Biological Conservation*, 238, 108183.
- Sini, M., Katsanevakis, S., Koukourouvli, N., Gerovasileiou, V., Dailianis, T., Buhl-Mortensen, L., Damalas, D., Dendrinou, P., Dimas, X., Frantzis, A., Gerakaris, V., Giakoumi, S., Gonzalez-Mirelis, G., Hasiotis, T., Issaris, Y., Kavadas, S.G., Koutsogiannopoulos, D.D., Koutsoubas, D., Manoutsoglou, E., Markantonatou, V., Mazaris, A.D., Poursanidis, D., Papatheodorou, G., Salomidi, M., Topouzelis, K., Trygonis, V., Vassilopoulou, V., Zotou, M. (2017), Assembling Ecological Pieces to Reconstruct the Conservation Puzzle of the Aegean Sea. *Frontiers in Marine Science*, 4, 347.
- Synge, H. (2004). European models of good practice in protected areas. IUCN Publications Services Unit, Cambridge.
- Toomey, A.H., Domroese, M.C. (2013). Can citizen science lead to positive conservation attitudes and behaviors? *Human Ecology Review*, 20, 50-62.
- UN (2015). General Assembly resolution, Transforming our world : the 2030 Agenda for Sustainable Development, 21 October 2015, A/RES/70/1, available at: <https://www.refworld.org/docid/57b6e3e44.html> [accessed 7 October 2021]
- UN (2019). General Assembly resolution 73/284, United Nations Decade on Ecosystem Restoration (2021–2030), A/RES/73/284, available at: undocs.org/en/A/RES/73/284 [accessed 6 March 2019].
- UNECE (1998). Convention on access to information, public participation in decision-making and access to justice in environmental matters. Aarhus, Denmark. Available at: <https://ec.europa.eu/environment/aarhus/>

Hermoso, V., Carvalho, S.B., Giakoumi, S., Goldsborough, D., Katsanevakis, S., Leontiou, S., Markantonatou, V., Rumes, B., Vogiatzakis, I.N., Yates K.L. (2022). The EU Biodiversity Strategy for 2030: opportunities and challenges on the path towards biodiversity recovery. *Environmental Science and Policy*, 127, 263-271.

Vogiatzakis, I.N., Litskas, V.D., Koumpis, T., Kassinis, N., Constantinou, E., Leontiou, S.

(2020). The past, present and future of nature conservation in Crete and Cyprus: So close and yet so far. *Environmental and Sustainability Indicators*, 8, 100070.

Yates, K.L. (2014). View from the wheelhouse: Perceptions on marine management from the fishing community and suggestions for improvement. *Marine Policy*, 48, 39-50.

Yates, K.L. (2018). Meaningful stakeholder participation in marine spatial planning with offshore energy. In: *Offshore Energy and Marine Spatial Planning*, (Yates, K.L., Bradshaw, C.J.A., Eds.). Routledge.

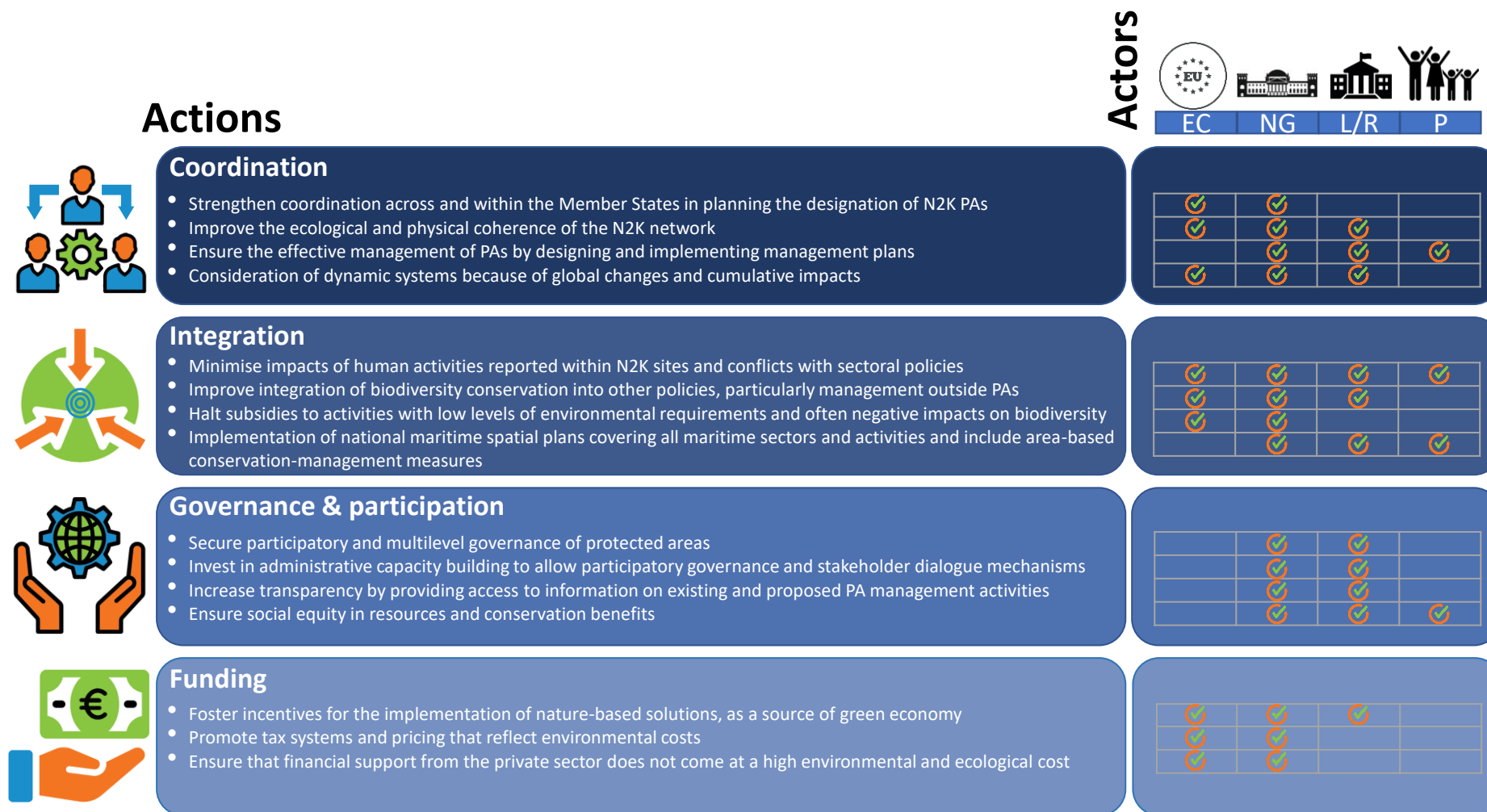
Yates, K.L., Clarke, B., Thurstan, R.H. (2019). Purpose vs performance: What does marine protected area success look like? *Environmental Science & Policy*, 92, 76-86.

Yates, K.L., Schoeman, D., Klein, C.J. (2015). Ocean zoning for conservation, fisheries and marine renewable energy: Assessing trade-offs and co-location opportunities. *Journal of Environmental Management*, 152, 201-209.

Figure 1. Strengths and weaknesses of past conservation policies and practice in the European Union, as well as opportunities and challenges for conservation in the coming decade.



Figure 2. Summary of actions for each pillar suggested in this study and the actors that need to take part in their implementation. EC: European Commission; NG: National governments; L/R: Local or Regional Governments; P: Public.



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Table 1. Summary of action recommendations for different EU biodiversity conservation policy instruments.

EU policy instrument	Development needs for effective biodiversity conservation
Biodiversity Strategy	<ul style="list-style-type: none"> ● Promote Private to Public Partnerships ● Promote Payment for ES provision
Marine Strategy Framework Directive Maritime Spatial Planning Framework Directive	<ul style="list-style-type: none"> ● Further integrate biodiversity conservation into maritime sectoral policies ● Improve coordination among Member States for addressing transboundary threats to biodiversity (e.g., marine litter) ● Improve ecological coherence of marine protected areas and N2K when planning marine spatial plans
Common Agriculture Policy	<ul style="list-style-type: none"> ● Incorporate spatial planning in target-setting and implementation ● Promote result-based payments ● Promote funds to protect High Nature Value Farmland within N2K
Common Fisheries Policy	<ul style="list-style-type: none"> ● Shift from subsidies to result-based payments ● Evaluate the contribution of Fisheries Restricted Areas towards the achievement of biodiversity targets ● Promote ecosystem-based management measures outside marine protected areas that have conservation benefits
European Green Deal	<ul style="list-style-type: none"> ● Adequate spatial planning to minimise conflicts (e.g. energy production vs biodiversity)
European Agricultural Fund for Rural Development European Maritime and Fisheries Fund European Regional Development Fund European Maritime Fisheries and Aquaculture Fund	<ul style="list-style-type: none"> ● Earmark funds for conservation ● Dedicate funds for compensation of fishers/farmers and other sea and land users that contribute to threat management
Aarhus Convention	<ul style="list-style-type: none"> ● Facilitate public participation in PA management