

REVIEW

Call for integrating future patterns of biodiversity into European conservation policy

Moritz M. Adam¹ | Bernd Lenzner² | Mark van Kleunen^{3,4} | Franz Essl²

¹Faculty of Science, University of Amsterdam, Amsterdam, The Netherlands

²Department of Botany and Biodiversity Research, University of Vienna, Vienna, Austria

³Department of Biology, University of Konstanz, Constance, Germany

⁴Zhejiang Provincial Key Laboratory of Plant Evolutionary Ecology and Conservation, Taizhou University, Taizhou, China

Correspondence

Moritz M. Adam, University of Amsterdam, Amsterdam Spui 21, 1012 WX, The Netherlands.
 Email: mo.adam@student.uva.nl

Mark van Kleunen and Franz Essl are joint last authors.

Abstract

Given the unprecedented rates of global warming, widespread shifts in species' distributions are anticipated to play a key role for their survival. Yet, current conservation policies often allocate priority to native species and their typical habitats, thereby preserving historic conditions rather than preparing for future species distributions. Policy initiatives aimed at halting biodiversity loss, such as the EU 2030 Biodiversity Strategy, could provide an opportunity to proactively integrate species' future distributions into conservation objectives on an international scale, for example, by encouraging management actions that allow for species migration along projected paths of dispersal. Acknowledging climate-tracking species as a conceptually distinct phenomenon, we qualitatively analyzed to which extent the EU 2030 Biodiversity Strategy and the legal framework it is embedded in, such as the Draft Note on Designation Criteria (ENV.D.3/JC) and the Framework for Blue and Green Infrastructure (SWD/2019/193), integrated climate-trackers into their conservation objectives. We found that the Biodiversity Strategy did not explicitly incorporate future patterns of species distributions into conservation planning but emphasized the maintenance of historical community compositions and species distributions. While the commitments in these legal documents to nature restoration will certainly be helpful for biodiversity conservation today and after 2030, it may miss the chance to be a more comprehensive conservation policy.

KEYWORDS

Anthropocene, climate change, conservation, EU 2030 Biodiversity Strategy, neoinvasives, range expanding species, redistribution ecology

1 | INTRODUCTION

Unless greenhouse-gas emissions are quickly and drastically reduced, global warming will exceed 1.5°C compared to preindustrial climate within the next three decades (IPCC, 2021) with profound effects on biota (Pörtner et al.,

2021). Part of species' response repertoire to warming includes changes in their geographical distributions. To track their ecological niche, species will have to shift their range (Pecl et al., 2017). Given the unprecedented pace of global warming (IPCC, 2021), shifts in species spatial distribution could predominate evolutionary adaptation to

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climatic changes and will likely play a key role for survival. In fact, range shifts for more than 12,000 taxa (Jonathan Lenoir et al., 2020), with an average latitudinal movement rate of 70 km per decade for marine (Poloczanska et al., 2013), and 17 km per decade for terrestrial taxa (Chen et al., 2011) have already been reported. This poses an enormous challenge for conservation managers, as current conservation practices must not only withstand stressors driving global extinctions, but also protect species on the move through fragmented landscapes and across jurisdictional borders. Nevertheless, future species distributions are rarely integrated into transnational conservation policies undermining the effectiveness of management action and obstructing wider conservation efforts.

Existing conservation policies were not designed for handling massive changes in environmental conditions as have become the hallmark of the Anthropocene (Steffen et al., 2015) and that precipitate widespread ecological changes. Instead, biodiversity conservation is largely based on static systems of protected areas in which particular species and ecosystems are safeguarded through mandated goals of institutions (Heller & Zavaleta, 2009). But when many species begin to track their niches via range shifts in response to climate change, they may lose representation in their former habitats (Semenchuk et al., 2021). As a result, already established protected areas may become ineffective for safeguarding the species and ecosystems they were meant to protect since target species may migrate elsewhere (Heller & Zavaleta, 2009) (see Box S1 for an example). To cope with these shortcomings, conservation objectives may have to be broadened from prioritizing in situ conservation and preserving historical conditions toward more pragmatic strategies for maintaining biodiversity and ecosystem functions under future distribution patterns (McDonald et al., 2016; Melbourne-Thomas et al., 2021; Urban, 2020).

Informed by recent advances in redistribution ecology, a vibrant debate on the design of viable conservation strategies and management options under climate change has started (Maureaud et al., 2021; Bonebrake et al., 2018; Hobbs et al., 2018; Pinsky et al., 2018). Generally, range shifts are valued as a cheap and effective form of ecological resilience beneficial to biodiversity maintenance since successful spatial adaptation signifies species persistence (Scheffers & Pecl, 2019; Urban, 2020; Wallingford et al., 2020). Further, it has been recommended to facilitate species movement across biogeographical barriers to prevent extinctions in the case species fail to persist in situ (Scheffers & Pecl, 2019; Urban, 2020). On the other hand, the potential for biological invasions and other negative impacts at sites of range extension has gained attention (Procheş et al., 2005). Especially where climate change allows for range expansions of species with “weedy” traits,

such as forest and crop pests or carriers of diseases, the cost for recipient communities could be immense (Wallingford et al., 2020; Carlson et al., 2021). Thus, the challenge for biodiversity conservation under climate change must be to manage spatial adaptation in a way that enables species redistribution to maintain biodiversity while preventing harmful effects to recipient communities.

A decisive step toward meeting this challenge is by integrating likely future patterns of biodiversity into current conservation planning since management actions may only achieve their full impact when strategically employed along projected paths of dispersal. Considering the scale and magnitude of current species redistribution, there is a need for a coherent conservation regime across nation states. Transnational political actors such as the European Union (EU) have the capacity to introduce such initiatives by a forward-thinking policy design that adopts the concept of climate-driven range shifters into conservation targets. For example, current negotiations on the EU 2030 Biodiversity Strategy could provide an opportunity to make a first step in such direction. Using the Biodiversity Strategy as a case study, the aim of this paper is to inform about management options related to species redistribution and to raise awareness of their incorporation (or lack thereof) in European conservation policy. The definitions used in this manuscript are listed in Table 1 (see [supporting information](#)).

1.1 | Redistribution ecology as an emerging research field

The geographic dimensions demarcating a species distribution are latitude, longitude, and elevation or depth (Lenoir & Svenning, 2015). In the face of global warming, isotherms are shifting toward higher latitudes and altitudes (Burrows et al., 2011). For many species, this translates into a poleward expansion of the leading edge of their potential distributions, or an altitudinal shift toward higher elevations or deeper waters (Pecl et al., 2017; Rumpf, Hülber, Zimmermann, et al., 2019). For example, increased temperatures may allow species to inhabit areas that were historically too cold for establishing. In contrast, other areas may become too hot for sustaining populations leading to range contraction on the warm edges of species' distributions (Pecl et al., 2017).

The substantial increase of research on the mechanisms as well as ecological and evolutionary consequences of climate-driven range shifts has been associated with the emergence of a new research field sometimes labeled “species redistribution ecology” (Bonebrake et al., 2018). One of its main insights is that directional range shifts substantially differ in form, magnitude, and pace among

TABLE 1 Definitions of terms as used in this manuscript

Term	Definition
“Native”	A species that came into being through evolutionary means or established itself through natural dispersal (sensu Essl et al., 2019)
“Alien”	A species that overcame biogeographical barriers through intentional or unintentional human action (sensu Pyšek et al., 2020)
“Invasive Alien”	(1) An alien species that established and substantially spread from its introduction site (sensu Pyšek et al., 2020), or (2) an alien species that exhibits harmful effects on economy, environmental or health (IUCN, 2000 as cited in Pyšek et al., 2020)
“Neonative”	“Taxa that have expanded geographically beyond their native range and that now have established populations whose presence is due to human-induced changes of the biophysical environment, but not as a result of direct movement by human agency, intentional or unintentional, or to the creation of dispersal corridors such as canals, roads, pipelines, or tunnels” (Essl et al., 2019)
“Establishment”	A species is considered established once it reproduces regularly from self-sustaining populations (sensu Pyšek et al., 2020)
“Ecological Novelty”	Evolutionary experience of interacting resident and nonresident species (sensu Saul & Jeschke 2015, as cited in Essl et al., 2019)

species. While some species depend on each other to sustain their populations and may lag behind their host or prey when shifting geographic ranges, other species have limited dispersal capacities, or are facing hostile landscapes that limit spread velocity; as a consequence, relocations of entire ecosystems are highly unlikely (Hellmann et al., 2012). This asynchronous response leads to a disruption of historic species interactions as well as the establishment of new ones (Bonebrake et al., 2018; Scheffers et al., 2016; Zarnetske et al., 2012). Particularly shifts of keystone species could lead to changes that significantly alter ecosystem functioning by disrupting existing species-interaction networks or initiating cascading effects (Gilman et al., 2010).

In this context, it has been proposed to view climate-driven range shifters through the lens of invasion biology to address possible negative effects on recipient communities (Wallingford et al., 2020). The concern here is that range shifters could have undesirable effects on biodiversity like some alien taxa, especially invasive alien species (IAS) (Essl et al., 2019; Wallingford et al., 2020). While the phenomenon of range shifters responding to human-made climate change certainly blurs the line between prevailing dichotomous distinctions that assign either native or alien status to species, spread characteristics notably differ among alien and climate-driven species, and result in different evolutionary outcomes (Essl et al., 2019). Alien species depend on active or direct human agency for relocation, for example, through transport or release, or on the establishment of transport corridors (such as canals between different river catchments or oceans). This form of spread makes it possible to overcome biogeographical barriers over vast distances, or across barriers that could not have been crossed otherwise. However, range shifters do not experience anthropogenic propagule pressure in

that sense but disperse from their historical native range toward adjacent territories (Essl et al., 2019). Because range shifters have a shared evolutionary history with the recipient community at their range margins, interactions are not completely novel (Essl et al., 2019). Accordingly, the factor of ecological novelty, a key trait associated with invasive effects, is expected to be much less pronounced (Urban, 2020; Wallingford et al., 2020).

2 | MANAGING CLIMATE-TRACKING SPECIES

To be able to employ efficiently targeted conservation measures on climate-tracking species, it could be helpful to install a framework that is tailored to their distinct features (Urban, 2020). An important step in such a direction would be an agreed upon definition for climate-tracking species. Taking the differences of spread dynamics, characteristics, and impacts of climate-tracking taxa into account, Essl et al. (2019) proposed the term “*neonatives*” for range expanders responding to global warming to signify the biogeographic status of such taxa, that is, that their presence in the territory of expansion is comparatively recent. The definition goes as follows:

“*Neonatives* are those taxa that have expanded geographically beyond their native range and that now have established populations whose presence is due to human-induced changes of the biophysical environment, but not as a result of direct movement by human agency, intentional or unintentional, or to the creation of dispersal corridors such as canals, roads, pipelines, or tunnels.” (Essl et al., 2019)

By acknowledging human-induced changes of the biophysical environment as the reason for range expansion, this definition concretizes the role of human agency and thereby addresses ambiguities that previous dichotomic classifications failed to tackle. Recognizing *neonatives* as a conceptually distinct phenomenon in current conservation objectives may help providing a more pragmatic action-target for management options. Additionally, adoption of such a concept in legal conservation objectives can help to clarify aspirational outcomes for drafting and implementation of policy, identify priorities, guide resource allocation and set a reference point for assessing effectiveness of implemented measures (McDonald et al., 2016). Most importantly, the proposed definition highlights the distinct features of climate-tracking species from which a set of conservation implication may be inferred:

First, *neonatives* rely on spatial adaptation as a response mechanism for survival under changing environmental conditions. But species on the move are likely to encounter many barriers as landscapes outside protected areas are often hostile and heavily fragmented, impeding gene flow and limiting species migration (Heller & Zavaleta, 2009). To overcome these constraints, it has been suggested to facilitate movement through implementing strategies that increase connectedness and permeability between resource patches (Bonebrake et al., 2018). More precisely, this may entail reforestation measures, creation of ecological corridors or positioning of reserves along environmental gradients (Heller & Zavaleta, 2009; Mawdsley et al., 2009). Ideally, connectivity measures are designed based on projected paths of dispersal, thereby integrating current and likely future patterns of biodiversity. For example, possible candidates for future reserves may include microrefugia, which are areas sheltered from broader environmental changes over time and therefore refugia where species can survive despite being apart from their main distribution area (Lenoir et al., 2017; Scherrer & Körner, 2009). Another way to facilitate species on the move is to implement temporally and spatially dynamic measures such as temporal closures or establishment of protected zones with moving boundaries (Melbourne-Thomas et al., 2021), which can arguably be difficult to realize in practice given the different land-owners and stakeholders involved. Of course, some taxa will persist in situ because of their tolerance to broad environmental conditions, through physiological and behavioral alterations, or by adjusting life cycle events such as flowering, fruiting, or seasonal migration (Bellard et al., 2012; Hobbs et al., 2018). However, persistence may also be the result of restricted dispersal capability due to intrinsic (e.g., depended on species traits) or extrinsic factors (e.g., depended on topography). Failed or delayed spatial response may result in a disequilibrium between temperature conditions and assemblage

that effectively induces extinction debt (Bertrand et al., 2016; Jackson & Sax, 2010; Rumpf, Hülber, Wessely, et al., 2019). Stayers caught in an ecological trap could be aided through improving the quality of habitats where species are still present, especially those refugia that provide sheltered from broader environmental instabilities over time (Jonathan Lenoir et al., 2017). Further, species that fail to move and are threatened by extinction, in particular those which perform important ecosystem functions, could be protected through active relocation to environmentally suitable areas elsewhere (Brodie et al., 2021). However, assisted migration as an interventionist management strategy is critically debated and often viewed as a last-alternative option only due to uncertainty for both targeted taxa as well as recipient communities (Mueller & Hellmann, 2008).

Second, another conservation implication may be deduced from the fact that *neonatives* respond to changes in the “biophysical environment,” rather than just “climate,” as the reason for range expansion. This broadens the scope from climate change to other human-induced environmental alterations such as land-use change. Widening the scope is important since biophysical changes to the environment, for example, dams, intensive agricultural use, or long-stretched fences can pose insurmountable barriers to species on the move (Tittley et al., 2021). Since the degree to which suitable environmental space is redistributed depends on the extent of climate warming as well as land-use changes, measures that aim at attenuating the magnitude of range shifts and possible negative consequences for recipient communities should limit greenhouse-gas emissions and land-use in concert. Moreover, a new conservation paradigm should recognize that ecological turnover, climate change, and land-use are interlinked. On the other hand, such multi-purpose management strategies could make the allocation of limited funds appear untargeted, especially when including nonquantifiable targets. For example, it may be difficult to ascertain the degree to which greenhouse gas emission reductions benefit particular species with high conservation value.

Third, *neonatives* have the potential to create nonanalog communities when the expansion to new suitable environmental space leads to the crossing of biogeographical barriers. From a conservation perspective, this implies that harmful effects on recipient communities, for example, the possibility for biological invasion or pathogen spill over, must be addressed. To avoid negative impacts on recipient communities, invasion biology may provide useful insights for developing management tools. Typical strategies for species with the potential to exhibit invasive effects focus on pathways of introduction and preventive measures (Pyšek et al., 2020). Adopting this approach, problematic

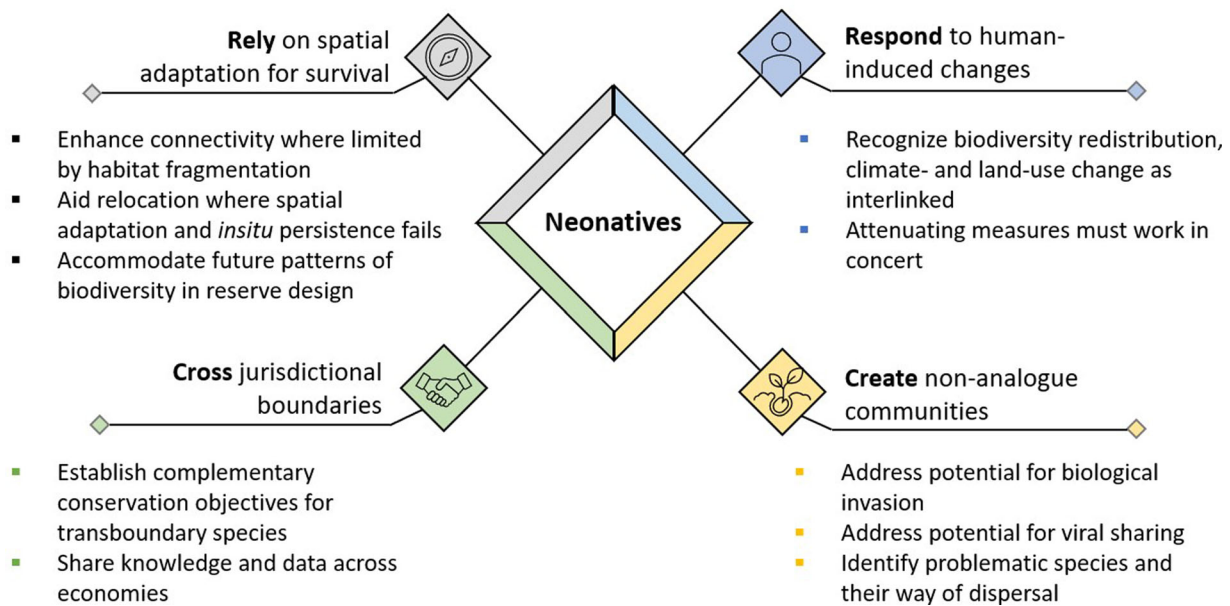


FIGURE 1 The four conceptually distinct features of neonatives may imply corresponding management options—a set of which are represented in this figure

species, and their dispersal pathways must first be identified. Large-scale and long-term monitoring strategies that rely on standardized systems of data acquisition and uncertainty estimates could provide most useful for tracking range shifters (Melbourne-Thomas et al., 2021). A downside to this approach may be incorrect targeting of species on the move that do not exhibit invasive behavior and might thus become more prone to local extinction.

Lastly, *neonatives* are likely to cross administrative borders of nation states. Climate-tracking may be substantially hindered if distinct management imperatives are in place across borders. Improved cooperation between jurisdictions is needed to set overarching goals for adequate management of *neonatives* and prevent mismatched conservation action or the random creation of climate-change winners and losers (Melbourne-Thomas et al., 2021; Scheffers & Pecl, 2019; Titley et al., 2021). A synthesis of *neonatives* distinct features and possible implications for management can be seen in Figure 1.

While the neonative-concept provides clear benefits for a more nuanced discussion for future policy and management strategies, the fact that the concept was developed recently necessitates that there are associated limitations that need to be clarified by the scientific community. These limitations revolve around spatial and temporal criteria and the role of direct and indirect human agency. Essl et al. (2019) suggest that to be considered as neonative a species must expand beyond its native range (excluding recolonization) and acquire at least ephemeral population status in the area of expansion. In addition, neonatives' populations are suggested to be those established after the onset of

the Anthropocene (i.e., 1950 following Waters et al., 2016; Zalasiewicz et al., 2015) that marks the epoch of predominant human influence. Finally, indirect or direct human agency classification will likely be based on circumstantial evidence following close matches between species requirements and recent human-induced changes to the recipient communities. While all these criteria are still under debate, we still consider the concept appropriate for illustrating related management options (for a more thorough debate see Essl et al., 2020; Essl et al., 2019; Sagoff, 2020; Wilson, 2020).

3 | NEONATIVES AND THE EU BIODIVERSITY POLICY

An analysis of the EU 2030 Biodiversity Strategy (henceforth: the Biodiversity Strategy), Europe's latest policy initiative to halt biodiversity loss, may provide some relevant insights on the status of the integration of species' future distributions into international conservation planning. The Biodiversity Strategy is not a stand-alone project but is part of the European Green Deal, which encompasses several policy initiatives aimed at positioning the EU on a sustainable trajectory and as a global leader in climate and biodiversity negotiations (COM/2019/640) (see Figure 2).

The Biodiversity Strategy was adopted in June 2021. According to the Biodiversity Strategy, at least €20 billion will be unlocked for the restoration of ecosystems, expansion of protected areas and investments in green

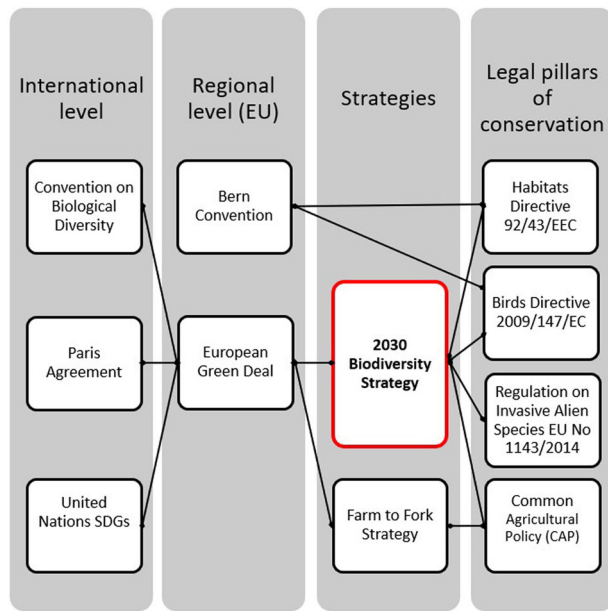


FIGURE 2 Selection of global and European legal documents linked to the EU 2030 Biodiversity Strategy (marked in red). As part of the European Green Deal, the 2030 Strategy should be interpreted in the light of linkages to other international obligations such as the 1992 Convention on Biological Diversity (CBD), the UN 2030 Agenda for Sustainable Development, and the 2015 Paris Agreement on Climate Change (COM/2020/380). On the EU level, the Strategies aims to increase protected areas and are legally embedded into the 1992 Habitats Directive (92/43/EEC) and the 1979 Birds Directive (79/409/EEC), which together form the cornerstone of Europe's conservation policy. In their objective, the Directives are tied to the 1978 Bern Convention. Additionally, the 2030 Strategy is linked to the CAP, which governs large part of EU territory and provides a substantial share of EU biodiversity funding. Actually, the Strategies and the legal pillars of conservation function on an EU level as well. Here, they are separated for better visual representation

infrastructure (COM/2020/380). More specific goals include for example the protection of 30% of the EU's land by 2030. Further, protected areas should be designated in a way that promotes a network character, that is, by closing gaps between existing reserves and establishing ecological corridors (COM/2020/380).

In the context of climate-tracking species, reserve expansion, and increased connectivity are useful measures. The new reserves will be integrated into the EU's existing protected area network—Natura 2000. Natura 2000 is legally embedded into the 1992 Habitats Directive (92/43/EEC) and the 1979 Birds Directive (79/409/EEC), which together form the cornerstone of Europe's conservation policy. However, the development of the Directives dates 30–40 years back and they were not designed to manage species redistribution under rapid climate change. The general approach of both Directives to conservation is twofold: they reserve land within the public territory of member

states for conservation purposes and additionally adopt lists of species and habitats that should be protected. In fact, conservation priority is mainly allocated to native species and their typical habitats (for designation criteria see Annex III of the Habitats Directive). Because the 2030 Biodiversity Strategy builds and expands upon the legal framework of the Directives, it may be inferred that protection status is mostly granted to natural habitats and native species. This may lead to the preservation of historic conditions rather than preparing for future species distributions. Moreover, since sites chosen for protection under the two Directives may not correspond to future species distributions, the Biodiversity Strategy could miss the chance to initiate more proactive solutions that more explicitly incorporate likely future patterns of biodiversity into conservation planning. While the Triade of reserve expansion, coherence, and corridors is likely to facilitate spatial adaptation of species under climate change by safeguarding and connecting valuable environmental spaces, more specific conservation action targeted at *neonatives* is lacking. It may be necessary to integrate future species distributions more explicitly into the designation criteria to ensure that corridors and reserves that are set up today do not lose their effectiveness as species migrate away from their historic distributions.

The process of defining exact criteria for the designation of protected areas is still undergoing discussion, and already a second version of designation criteria has been released in February 2021. The “Draft Technical Note on Criteria and Guidance for Protected Areas” emphasizes that particular attention should be paid to “creating the adequate conditions for the movement of species or habitats and more generally for increasing nature's capacity to adapt to climate change” (ENV.D.3/JC). Additionally, the Biodiversity Strategies' ambitions to enhance habitat connectivity are informed by the “Guidance on a Strategic Framework for further supporting the Deployment of EU-level Green and Blue Infrastructure” (SWD/2019/193). Here, the significance of habitat connectivity for spatial adaptation of climate-trackers is directly acknowledged: “in a context of climate change and temperatures increase, removing barriers to species movement is critically important for conserving biodiversity, as this allows e.g. species to migrate to areas that are more favourable” (SWD/2019/193). These two documents incorporate the insight that species will migrate because of climate change, which shows that policy makers are aware of the phenomenon of range-expanding species. However, an explicit call for integrating potential future distributions patterns into site designation of reserves and corridors is missing. An overview of selected quotes from the Biodiversity Strategy and related policy documents with an interpretation in the light of *neonatives* is given in Table 2.

TABLE 2 Interpretation of exemplary quotes from the EU 2030 Biodiversity Strategy and related documents in the light of the four conceptually distinct features of neonatives (see Figure 1)

Conservation implication: <i>neonatives</i> rely on spatial adaptation for survival		
Document	Quote	Interpretation
EU 2030 Biodiversity Strategy (COM/2020/380)	“In order to have a truly coherent and resilient Trans-European Nature Network, it will be important to set up ecological corridors to prevent genetic isolation, allow for species migration, and maintain and enhance healthy ecosystems. In this context, investments in green and blue infrastructure [...] should be promoted [...].”	While climate-tracking species in general (and <i>neonatives</i> in particular) remain undefined throughout the Strategy, the importance of habitat connectivity for species migration under climate change is adopted into conservation planning.
Draft Note on Designation Criteria (ENV.D.3/JC)	“Particular attention should also be given to creating the adequate conditions for the movement of species or habitats and more generally for increasing nature’s capacity to adapt to climate change.”	The need of “adequate conditions” for range shifting species as a response to climate change is acknowledged. However, instructions for a more proactive integration of future biodiversity distribution into conservation planning are lacking.
Framework for Blue and Green Infrastructure (SWD/2019/193)	“In a context of climate change and temperatures increase, removing barriers to species movement is critically important for conserving biodiversity, as this allows, e.g., species to migrate to areas that are more favourable. In that context, EU-level green and blue infrastructure projects, by improving or restoring the connectivity of biodiversity areas, can contribute to adapt to climate change and to protect species at risk.”	Here, the significance of habitat connectivity for spatial adaptation of climate-trackers is directly acknowledged. While it is the only direct recognition of the phenomenon of climate-trackers in the context of the 2030 Biodiversity Strategy, it shows that the issue of climate-driven species redistribution at least has reached policymaking. However, clear instructions for taking future redistribution patterns into account when locating suitable areas for corridors are missing.
Conservation implication: <i>neonatives</i> respond to human-induced changes		
Document	Quote	Interpretation
EU 2030 Biodiversity Strategy (COM/2020/380)	“The biodiversity crisis and the climate crisis are intrinsically linked. Climate change accelerates the destruction of the natural world [...] while the loss and unsustainable use of nature are in turn key drivers of climate change. But just as the crises are linked, so are the solutions. Nature is a vital ally in the fight against climate change.”	As part of the Green Deal, the 2030 Strategy belongs to a set of policy initiatives that address climate change and biodiversity issues at the same time. The Strategies’ holistic understanding of the biodiversity crisis is essential for attenuating range shifts in the future as <i>neonatives</i> respond to both climate- and land-use change.
Conservation implication: <i>neonatives</i> create nonanalog communities		
Document	Quote	Interpretation
EU 2030 Biodiversity Strategy (COM/2020/380)	“The implementation of the EU Invasive Alien Species Regulation and other relevant legislation and international agreements must also be stepped up. This should aim to minimise, and where possible eliminate, the introduction and establishment of alien species in the EU environment.”	Considering the differences in spread dynamics, characteristics and impacts of alien and <i>neonatives</i> , the Biodiversity Strategy so far lacks an action plan for addressing possible negative impacts on recipient communities, e.g., from climate-tracking species with “weedy” traits or carriers of diseases.

(Continues)

TABLE 2 (Continued)

Conservation implication: <i>neonatives</i> rely on spatial adaptation for survival		
Document	Quote	Interpretation
EU Regulation No 1143/2014 on the Prevention and Management of the Introduction and Spread of Invasive Alien Species	“Some species migrate naturally in response to environmental changes. They should not be considered as alien species in their new environment and should be excluded from the scope of this Regulation. This Regulation should focus only on species introduced into the Union as a consequence of human intervention.”	The EU Regulation No 1143/2014 on IAS explicitly excludes species responding to environmental changes and may not provide any legal basis for targeting <i>neonatives</i> that exert harmful effects on recipient communities. However, it is likely that Member States have their own biosecurity measures giving them legal backing for targeting <i>neonatives</i> that have negative for recipient communities.
EU 2030 Biodiversity Strategy (COM/2020/380)	“The fight against biodiversity loss must be underpinned by sound science. Investing in research, innovation and knowledge exchange will be key to gathering the best data and developing the best nature-based solutions.”	Increased funding through the Horizon Europe Program could be an opportunity for further investigation on <i>neonatives</i> , their pathways, and effects on recipient communities. It may allow for funding of enhanced monitoring programs. This could be especially useful for identifying <i>neonatives</i> that cause negative impacts, as they remain unaddressed within the Strategy. However, funding for research on <i>neonatives</i> is only likely to happen if more explicitly accepted as necessary for reaching the objectives of the Strategy—which we argue it is.
Conservation implication: <i>neonatives</i> cross jurisdictional boundaries		
Document	Quote	Interpretation
EU 2030 Biodiversity Strategy (COM/2020/380)	“The EU is ready to lead all efforts—working with like-minded partners in a high-ambition coalition on biodiversity—to agree an ambitious new global framework for post-2020 at the upcoming 15th Conference of the Parties to the Convention on Biological Diversity.”	Facilitating cooperation among Member States is a key element throughout the Strategy. Existing cooperation initiatives, such as the European Territorial Cooperation (Interreg), could provide the governance framework needed for negotiations on range-expanding transboundary species. Additionally, the upcoming COP to the CBD may provide an opportunity to ensure more ambitious implementation of biodiversity targets and a possibility to draw attention to <i>neonatives</i> in conservation objectives.
EU 2030 Biodiversity Strategy (COM/2020/380)	“In order to have a truly coherent and resilient Trans-European Nature Network [...] cooperation across borders among Member States should be promoted and supported, including through the European Territorial Cooperation.”	

The Biodiversity Strategies' targets to expand protected areas go hand in hand with the promotion of new land-use strategies such as the post 2020 Common Agricultural Policy (CAP) framework or the "Farm to Fork" Strategy. The CAP plays a decisive role in achieving the 2030 Biodiversity Strategies' conservation objectives because 80% of the EU territory are covered by agricultural, forest or other farmed systems and it provides a substantial share of EU biodiversity funding (SWD/2020/93). Since its adoption in 1962, the CAP has incentivized marketization and intensification of agriculture, which is associated with a decline in biodiversity through increased use of chemicals per unit area, landscape homogenization, simplification, and specialization (Emmerson et al., 2016). Since previous reforms failed to reverse biodiversity decline in farmed systems (Pe'er et al., 2014), the CAP for the 2023–2027 period introduces a new "green" architecture aimed at increasing ambition for care for the environment (Regulation 2021/2115). In practice, the new CAP makes direct payments to farmers through the European Agricultural Guarantee Fund (or "Pillar I" of the CAP) and payments for wider rural development through the European Agricultural Fund for Rural Development (or Pillar II) conditional upon meeting certain (environmental) standards. These standards are either situated within the CAP framework (such as the Standards for Good Agricultural and Environmental Conditions (GAEC)—Annex III) or linked to other statutory management requirements (Annex XIII) such as the EU Directive of Sustainable use of Pesticides, the EU Water Framework Directive, Birds and Habitats Directives etc. (Regulation 2021/2115). Further, 25% (or €48.5 billion) of the direct payments to farmers is reserved for eco-schemes—an additional, voluntary payment scheme incentivizing practices beneficial for the environment (e.g., maintenance of fallow land and other nonproductive areas) and climate (e.g., carbon farming) (European Commission, 2021; European Commission, 2019). Lastly, 30% of Pillar II funding is ring-fenced for agrienvironmental climate measures (AECMs) which are payments aimed at compensating farmers and land-managers for multianual commitments to environmentally friendly practices. Through the system of enhanced conditionality, some elements of the CAP become aligned with objectives of the 2030 Biodiversity Strategy, the Farm to Fork Strategy, and the overall ambitions of the Green Deal. For example, obligations limiting the use of pesticides, antibiotics, and improved nutrient management relate to the Farm to Fork Strategies ambition of reducing nutrient losses and the use of chemicals in agriculture (SWD/2020/93). Voluntary payment schemes may complement the 2030 Biodiversity Strategies' goals by incentivizing the maintenance of high-diversity landscape features and nonproductive land

(SWD/2020/93). With regards to neonatives, the CAPs increased environmental ambitions have the potential to make farmed systems less hostile and better-connected environments thereby increasing the chances for successful spatial adjustment of geographic ranges in the light of climate change. Certainly, key to success of this green architecture is its ability to protect remaining landscape features and restore those degraded by agricultural intensification (Guy et al., 2021).

Furthermore, these new land-use strategies are complemented by a more ambitious climate-governance framework (see e.g., the Strategy on Adaption to Climate Change (COM/2021/82) or the EU Climate Pact). Throughout the Biodiversity Strategy, it is made explicit that "The biodiversity crisis and the climate crisis are intrinsically linked" (COM/2020/380, p.2). In the context of *neonatives*, this vision is substantial since the magnitude of range expansions can only be attenuated if climate and biodiversity action are implemented in a proactive and well-concerted manner.

Acknowledging that IAS are a significant threat to biodiversity, the Strategy emphasizes that the implementation of EU Regulation No 1143/2014, which adopts a list of IAS of Union concern must be stepped up. However, in the context of *neonatives*, this may not be adequate for addressing potential of biological invasion because it explicitly excludes species that "migrate naturally in response to environmental changes" (Art. 7). This means that on an EU-level, there is yet no legal basis for targeting *neonatives* exhibiting invasive effects. From a conservation perspective, this could even be positive since *neonatives* move in response to environmental changes naturally and the employment of control and eradication programs may contradict larger conservation efforts. Rather than a legal obligation to target problematic *neonatives*, the Strategies' announced investments into biodiversity research may be more helpful for identifying potentially problematic species.

Facilitating cooperation among Member States is emphasized as a key element throughout the Strategy, which is practical for managing *neonatives* that are likely to shift ranges across jurisdictional borders. Existing cooperation initiatives, such as the European Territorial Cooperation (Interreg), could provide the governance framework needed for negotiations on range-expanding transboundary species. Additionally, the upcoming conference of the parties to the CBD in China by the end of 2022 may provide an opportunity to position the EU as a leader in biodiversity policy and ensure more ambitious implementation of biodiversity targets and a possibility to draw attention to *neonatives* in conservation objectives.

4 | CONCLUSIONS

While the EU 2030 Biodiversity Strategy and its corresponding legal framework do not explicitly include *neonatives* into their conservation objectives, the guidelines underpinning the Strategy acknowledge that adequate conditions for movement of habitats and species under climate change should be taken into consideration (ENV.D.3/JC). They further highlight the role of relevant management tools such as ecological corridors (SWD/2019/193). We argue that the general commitment to protect biodiversity via expansion of protected areas in a coherent manner, by establishing ecological corridors, and by reducing environmental stressors from pollution, land-use or habitat fragmentation is likely to be beneficial for *neonatives*. This is because these measures provide more suitable environmental spaces for both occupancy and dispersal. Making reserves more resilient and more abundant while reducing human pressures on biodiversity and the climate system will benefit species today and under future redistribution scenarios. Moreover, the general commitment to biodiversity *benefits current and future patterns of biodiversity* at the same time.

On the other hand, biodiversity has already experienced a massive decline and temperatures are continuing to rise. While the Strategies' targets will certainly be helpful for slowing these developments, the policy initiative should also deal with unavoidable species redistributions. Given that conservation priority is allocated to native species and their typical habitats, the Biodiversity Strategy may put too much emphasis on maintaining historical compositions over ecosystem functions and could miss the chance to set-up foreseeing policy initiatives that explicitly incorporate future patterns of biodiversity into conservation planning.

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AUTHOR CONTRIBUTIONS

MMA drafted the initial manuscript. MvK and FE developed the concept of the study. All authors substantially contributed to the development of ideas discussed in the manuscript and to the writing.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no data sets were generated or analyzed during the current study.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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