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Review

Participatory scenarios for restoring European landscapes show a plurality of nature values

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Large-scale ecological restoration is crucial for effective biodiversity conservation and combating climate change. However, perspectives on the goals and values of restoration are highly diverse, as are the different approaches to restoration e.g. ranging from the restoration of cultural ecosystems to rewilding. We assess how the future of nature is envisioned in participatory scenarios, focusing on which elements of rewilding and nature contributions to people have been considered in scenario narratives across Europe. We used the Nature Futures Framework archetypes as a template to synthesize pluralistic perspectives of nature. We found that different values of nature are often represented as counteracting elements and fail to integrate the plural views of nature. *Nature as Culture* was the main archetype found in the scenarios, usually associated with positive impacts on the non-material benefits to people. Intrinsic values of nature (i.e., *Nature for Nature*) were associated with positive impacts on regulating benefits and negative impacts on material benefits, being the only archetype of future associated with positive impacts on all three components of rewilding. *Nature for Society* was associated with moderate positive impacts on material and regulatory nature contributions to people. Business as usual futures were associated with negative impacts on regulating and non-material benefits to people and on all three components of rewilding. Our results highlight two major gaps in the scenarios that should be addressed in participatory restoration planning and models. Firstly, there is a paucity of spatially explicit approaches, with most studies failing to transform the results of participatory scenario planning into model projections. Secondly, we found scenarios that explored co-benefits between multiple nature perspectives were overall missing from the literature. Novel scenario narratives and approaches that explore synergies among different nature values are needed to design future large-scale restoration where biodiversity recovery and human well-being are intrinsically linked and fostered.

Keywords: nature contributions to people, nature futures, participatory scenarios, restoration ecology, rewilding, spatially explicit models

Introduction

The restoration of ecosystems is increasingly recognized as an essential cross-cutting component of sustainability policies anchored in biodiversity conservation, climate mitigation, sustainable use of natural resources and human health (Navarro et al. 2017, Aronson et al. 2020, Fischer et al. 2020). Restoration efforts are central to the current draft of the post-2020 global biodiversity framework, which proposes an increase in the amount of area, connectivity and integrity of natural ecosystems by 2030 as one main goal for the protection of biodiversity (CBD/SBSTTA/24/3/Add.2/Rev.1 2021). Furthermore, there is increasing evidence that ecosystem restoration, when appropriately addressed, can contribute to climate change mitigation and adaptation (Girardin et al. 2021). Therefore, solutions to the biodiversity and climate crises require addressing the restoration of multiple dimensions of nature – from species populations to ecosystem functions – at a scale that can effectively reverse ongoing negative biodiversity trends (Mace et al. 2018). The restoration of multiple dimensions of nature should take the form of active or passive actions that aim at restoring the ecosystem structure and integrity towards self-sustaining ecosystems (Van Meerbeek et al. 2019).

Large-scale ecological restoration requires frameworks with well identified components that can be assessed in the context of land management and scenario building. Rewilding is an emerging approach to restoration that focuses on ecosystem complexity at multiple scales (Perino et al. 2019). It has gained attention for targeting the restoration of self-sustaining complex ecosystems through recovering lost species interactions and ecosystem functions, while, at the same time, addressing societal benefits and challenges entailed by nature restoration. It builds on ideas of process-oriented and open-ended restoration as a means to achieve the recovery of ecosystem functions (Torres et al. 2018, Jepson 2019, Van Meerbeek et al. 2019, Bullock et al. 2021).

Rewilding can sustain more abundant and functional wildlife (Svenning et al. 2016, Fernández et al. 2017), store more carbon in landscapes (Bello et al. 2015, Lewis et al. 2019), contribute to natural disturbance regulation (Pausas and Bond 2020), and help to mitigate the negative effects of climate change. Rewilding goals can be achieved through a broad set of management actions that range from forms of passive restoration following land abandonment (Navarro and Pereira 2012, Navarro et al. 2017), to active measures that contribute to the restoration of complex trophic networks and their functions (Svenning et al. 2016). Torres et al. (2018) provided a framework identifying the main components of rewilding and accommodate for this broad set of actions with an aggregated rewilding index measuring multiple ecological components of rewilding.

However, the relationship between the implementation of rewilding and the human use of the landscape remains complex. On the one hand, restored landscapes can provide recreational services such as wildlife watching and ecotourism (Cerqueira et al. 2015). Yet some goals of rewilding can alter the status quo of human–wildlife coexistence and generate novel conflicts (Fernández et al. 2017, Killion et al. 2020). Despite the acknowledgment of the complex relationships between rewilding outcomes and the societal perceptions of services and disservices (Killion et al. 2020), a more detailed evaluation of these interlinkages has remained elusive until now. One way to address this is by using the nature contributions to people (NCPs) framework, which embraces pluralistic views of nature and how it provides multiple services to humans (Díaz et al. 2018). It is thus an appropriate method for evaluating a wide range of services and disservices affecting people's quality of life.

Recent calls to acknowledge the pluralistic views of nature have highlighted that, too often, conservation and restoration projects fail to engage local communities in planning and implementing the actions, therefore increasing the risk of conflicts and compromising their trust (Fischer et al. 2020, Pereira et al. 2020, Pascual et al. 2021). In contrast, involving multiple stakeholders in the evaluation of the different values of nature helps to identify co-benefits between nature and peoples' quality of life (Fischer et al. 2020). One way to involve stakeholders is through participatory scenario planning (PSP), which considers different visions about the impacts of nature conservation and restoration practices on society.

To date, the majority of participatory scenarios have been centered on developing exploratory or target-seeking scenarios based on two main groups, the socio-economic pathways (SSPs) (O'Neill et al. 2017) and the IPBES Scenario Archetypes (Harrison et al. 2019). Whilst they have been successful in outlining the potential impacts of socio-economic trends, these scenarios have limitations in describing desirable outcomes for nature and its contributions to people. Recently the IPBES Expert Group on Scenarios and models developed the Nature Ffutures framework (NFF) to develop scenarios exploring multiple perspectives on the relationship between people and nature (Rosa et al. 2017, Pereira et al. 2020). This framework is particularly useful to assess different visions on nature conservation and restoration, as it explores use-values (including direct and indirect use), non-use values (including intrinsice values) and relational values (Kim et al. 2021, Mansur et al. 2022).

In this paper, we analyze how the future of nature has been depicted in Europe through the lenses of participatory scenarios. We did a systematic review to explore the landscape of participatory scenarios for restoration or land management in Europe. We assess to what extent components of rewilding and nature contributions to people (NCPs) have been already incorporated – implicitly or explicitly – within participatory scenario narratives. We then use the Nature Futures framework to assess how multiple perspectives of nature and outcomes of restoration interventions for both people and nature, are portrayed in the different scenario narratives.

Methods

Systematic literature review

We carried out a systematic review of the scientific publications and grey literature (case reports, project reports) focusing on participatory scenarios for land management, area-based conservation and/or ecosystem restoration in Europe. We used the ROSES (RepOrting standards for Systematic Evidence Syntheses), framework to guide the systematic review throughout the steps of searching, screening and critical appraisal (Haddaway et al. 2018). For this review, we consulted two different databases 'Web of Science' and 'Scopus' using a time frame between 2000 and 2020. We used two search strings (Supporting information) for the title, abstracts and keywords: 1) a combination of terms targeting publications on scenarios for landscape management (or the lack thereof, i.e. terms related to land abandonment which is particularly relevant in the case of rewilding in Europe (Navarro and Pereira 2012)), and 2) a combination targeted at scenarios for biodiversity conservation, restoration and rewilding. Our search returned a total of 3419 articles to which we applied the following inclusion criteria: the case study explicitly mentions the development of participatory scenarios, the participatory scenarios are located in Europe and are addressing, sustainable landscape management, biodiversity conservation, restoration, and/or rewilding or related components sensu Perino et al. (2019), that is trophic complexity, connectivity, disturbance. With these criteria, our initial pool of publications was narrowed down to 246 scenario storylines from 70 articles selected for the data synthesis and analysis. More information about the articles selected can be found in the Supporting information.

Assessment of the scenarios in the selected articles

We synthesised information of the different studies focusing on 3 main blocks of information: 1) general scenario components; 2) components of rewilding; and 3) of nature contributions to people. We then assessed to what extent each scenario matched the three NFF archetypes as well as the business-as-usual scenarios. Specifically, we generated a database containing the following information (Fig. 1 and Supporting information):

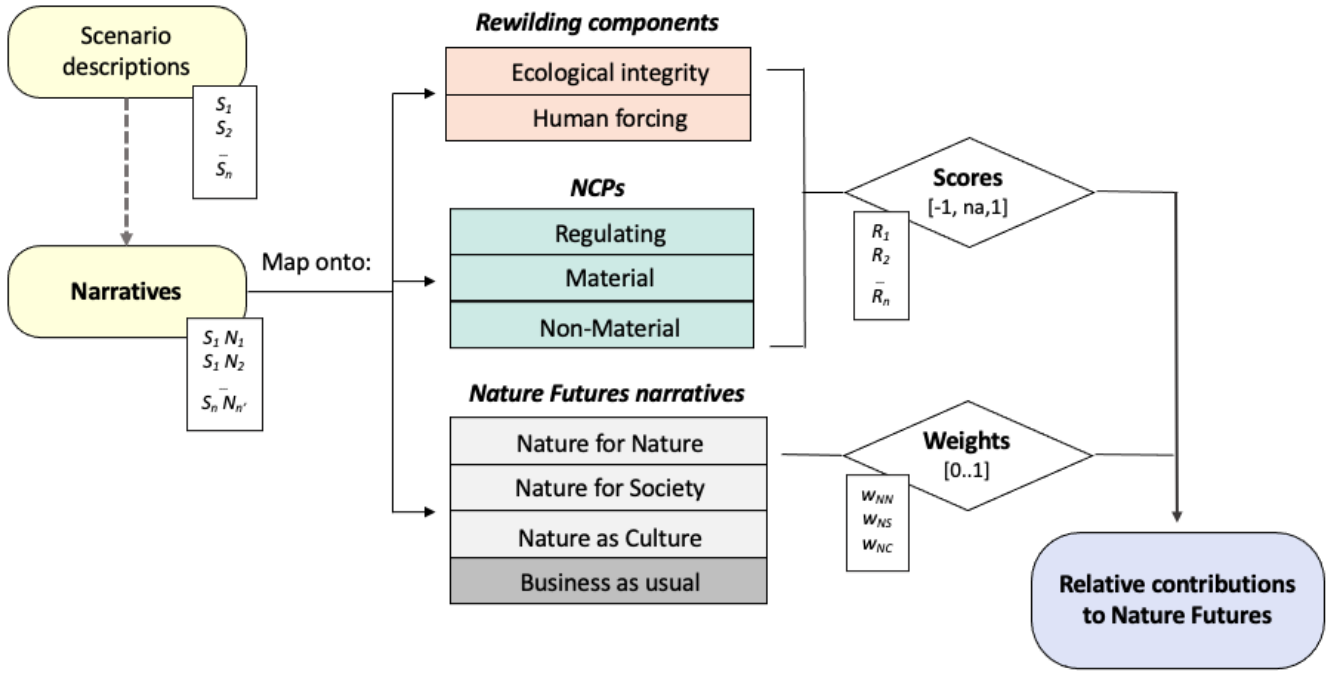
Scenario components: The information gathered was based on previous systematic reviews on participatory scenarios by Oteros-Rozas et al. (2015) and Thorn et al. (2020). We synthesized the information into the following categories: 1) bio-geographical location; 2) spatial scale: local, national, or regional; 3) temporal scale (in years); 4) land cover type; 5) goal of the scenario: target-seeking, exploratory or both; 6) purpose of the scenario: process or product-oriented outcomes; 7) scenario methods: backcasting or forecasting; 8) type of projections: quantitative (often model-based) or qualitative; and if the scenarios where spatially explicit were studies assign values to a geographical location based on the scenario's outcomes and finally 9) scope of the projections: changes in landscape, nature contributions to people, or biodiversity.

Rewilding components: Here we identified the elements of rewilding being considered in participatory processes by using the set of indicators defined in Torres et al. (2018) for measuring rewilding progress, nested within broader components of rewilding (see Torres et al. 2018 for a detailed list of indicators for each rewilding component and ways to quantify them and Supporting information). These components are divided into two categories: 'ecological integrity' which includes the restoration of connectivity (e.g. landscape fragmentation), stochastic disturbance (e.g. restoration of flooding regimes) and trophic complexity (e.g. community composition) of ecosystems and the 'reduction of human inputs and outputs' (e.g. reduction of cropland area and intensity). In particular, we assessed if rewilding components are explicitly considered within the scenario storylines, that is, as an intentional outcome of the scenario. The scoring of the different components was 1 if the scenario outcome had a positive effect (e.g. the restoration of connectivity) or −1 when negative effects resulted from the scenarios (e.g. increased fragmentation of the landscape). When the scenarios did not address the rewilding component, it was scored N.A as there was no information (Supporting information).

Nature contributions to people: we divided the assessment of the NCPS into the following sub-categories: regulatory, material and non-material NCPs according to Harrison et al. (2019). These categories were then further organized into individual NCPs such as the regulation of invasive species, food provision and pollination (for a full list of NCPs considered see Harrison et al. 2019 and Supporting information). As, for the rewilding components, we assessed when NCPs were explicitly considered as a part of the scenario storyline. We gave a score of 1 if the scenario mentioned positive effects on the NCP (e.g. an increase of food provision) or −1 when negative effects were mentioned in the narratives reviewed (e.g. decrease of food provision) and N.A where there was no information (for a detail description of the scores see Supporting information). Note that in most case-studies the scenarios will refer to 'ecosystem services' rather than NCPs, in part due to the fact that the NCP framework was proposed recently (Díaz et al. 2018). However, considering that ecosystem services to a large extent equivalent to nature contribution to people, this did not prevent us from mapping the narratives to the individual NCPs.

Matching and weighting of scenarios to the nature futures framework scenarios: We mapped the case studies scenarios to the nature futures framework (NFF) and the business-as-usual archetypes. The NFF is built on three non-mutually exclusive value perspectives of how people relate to nature, which are: 1) *Nature for nature,* centered on the intrinsic value of nature and where space i is allocated for (re)wild nature and for the preservation of nature's diversity and functions; 2) *Nature for society*, where nature is primarily valued

for the benefits to people including direct and indirect use values; 3) *Nature as culture,* in which the relationship between people and nature is valued as reciprocal, with people shaping nature (e.g. cultural landscapes) and nature shaping people, and people are seen as an integral part of nature (Pereira et al. 2020). To accommodate for the fact that some scenarios do not incorporate narratives that improve any nature values and therefore cannot be mapped into the nature futures framework, we added a contrasting scenario category 4) *Business-as-usual* that explores what is expected to occur if no action is taken to enhance biodiversity and/or ecosystem services (Fig. 1). We systematically assigned each scenario storyline from the case studies to one or several nature future scenarios based on the descriptions of the scenario storylines and the NFF archetypes description (Fig. 1). We then assessed how the different NCPs and rewilding components considered (or not) by each scenarios are reflected in each of the NFF as well as the business-as-usual scenario. To that purpose, we assigned a weight to each scenario of each case study depending on how closely they matched the nature future narratives and the business-as-usual scenario. We gave for each NFF and each scenario a weight between 0 and 1, where a value of 1 means that the scenario fully matched with the NFF archetype description, and 0 when there were no elements in common (Fig. 1). When a scenario did not match one NFF but rather multiple archetypes, we divided the score



Intrinsic value of nature. Preservation of nature diversity and functions is of primary importance. Possibility of a future in which extractive human activities and interventions are not allowed in natural areas. New laws, tax reforms and spatial planning ensure nature connectivity, sustainable cities and production of organic food.

Optimize Nature contributions to People. Promote innovative technology and the adaptation of agricultural practices to mitigate drivers of biodiversity loss. Circular economy, ecotourism and incentives for urban greening. Enforcement of laws and regulations and spatial planning. Increase green and blue infrastructure

Living in harmony with nature. Humans are an integral part of nature. The reciprocity of the people-nature relationships is valued. Change in lifestyle, education, and resource management with higher food diversity and eco-friendly farming. More equity in the access to biodiverse urban space and nature.

Narratives do not explore different values of nature. Society and industry are reluctant to adopt environmental policies that would lead to substantial improvements. Contrast scenario, i.e.: what is expected if no action is taken to enhance biodiversity conservation and/or ecosystem services supply

Figure 1. Schematic representation of the methodology used in this study. Descriptions of the steps used to map and synthesize the scenario narratives into the rewilding components (Torres et al. 2018), nature contributions to people (Harrison et al. 2019) and to map them into the nature futures framework archetypes (Pereira et al. 2020).

according to the elements found in the storylines. For example, if the scenario matched both with the nature for nature and nature for society visions, we assigned a weight of 0.5 for each of these two archetypes.

Analysis: Our overall goal was to explore how future visions for nature were considered in the different studies while assessing how those visions relate to both the various components of rewilding and nature's contributions to people. For this reason, we then multiplied the weighted values from the NFF visions with the rewilding components and NCPs scores previously obtained. We calculated the arithmetic mean and the quantiles for each NCP and rewilding component and plotted the results to observe the distribution of the NFF narratives and their negative (−1) or positive effects (1) on the rewilding components and NCPs (Fig. 1).

Results

Scenario components

The case studies were located in 18 countries and 5 different biogeographical regions in Europe (Fig. 2A). Most of the case studies were conducted at the local level (66.8%) and fewer studies were done at the national (20%) and regional scale (17.2%) (Fig. 2B). Around 30% of the scenarios were developed within a time horizon of 16–25 years (Fig. 2C). Most of the case studies were located in mosaic-type landscapes, where the most represented land cover were agricultural areas (26.9%) followed by forests (22.6%) and semi-natural grasslands (17.74%) (Fig. 2D).

Around 45% of the case studies described target-seeking scenarios as their main goal (Fig. 2E). Similarly, most of the case studies developed scenarios aimed at supporting management actions and policymaking. This is reflected in the purpose described for the participatory scenarios, where 55.6% of the case studies were process-oriented (Fig. 2F) and 53.3% used back-casting methods (Fig. 2G). The main function described for the participatory scenarios were to foster discussions and raise awareness in the community.

Around 74% of the case studies developed quantitative scenarios but only 45.7% of all quantitative scenarios were spatially explicit (Fig. 2H) and most case studies did not assign values to a location based on the scenario's outcomes. The most common type of projection used in the scenarios was related to envisioning changes in land-uses corresponding to 70% of the case studies (Fig. 2I). This was followed by changes in the provision of nature contributions to people within 47.1% case studies and 28.6% case studies that addressed changes in biodiversity (Fig. 2I).

Elements of rewilding and NCPs in the participatory processes

The most common elements found in the scenario narratives were NCPs (Fig. 3). In particular, we found a higher representation of material and non-material NCPs in the participatory scenarios. The components most mentioned in the scenarios storylines were lifestyle and culture (n = 67, 95.7% of the scenarios), food provision (n = 60, 85.7%) and regulation of services such as water, air and soil (n = 57, 81.4%).

In addition, we observed that rewilding components such as the recovery of large-bodied species was rarely considered in the scenario design (Fig. 3). Only 10 case studies (14.3%) addressed directly topics related to the recovery of large-bodied mammals and 31 case studies (44.3%) considered the restoration of natural disturbance regimes. The most common rewilding components addressed in the scenarios were linked to the reduction of human appropriation of natural resources such as agriculture with 58 case studies (82.9%) and forestry production with 51 case studies (72.9%). These elements are associated with the provision of material NCPs. This is followed by issues related to the use of the landscape affecting connectivity with 55 case studies (78.6%) and spontaneous vegetation dynamics 48 case studies (68.6%).

Matching and weighting of scenarios to the nature futures framework archetypes

Most of the scenario narratives within the case studies matched with *Nature as Culture* archetype, with a total of 46.74% of scenarios that shared similar storylines resulting from changes in lifestyle and education and better management of natural resources. This was followed by *Nature for Nature* with 38.8% scenarios, and *Nature for Society* with a total of 38.2% scenarios. Fewer scenarios matched the *Business-as-usual* narratives with a total of 29.6% of scenarios found with a corresponding storyline.

For the analysis of the rewilding elements found in the NFF archetypes we only took into account the components that refer to the ecological integrity of an ecosystem, that is connectivity, trophic complexity and stochastic disturbances. The majority of the positive contributions towards rewilding components were found in the *Nature for Nature* scenarios (Fig. 4). The component that most benefited under this type of scenario was the restoration of the trophic complexity with a mean of 0.54, followed by the restoration of connectivity within ecosystems, with a mean of 0.48, and stochastic disturbances with a mean of 0.41. However, not all NFF archetypes incorporated rewilding components. In *Nature as Culture* scenarios, we observed limited contributions towards the restoration of connectivity (0.05), trophic complexity (0.023) and stochastic disturbances (−0.04). Likewise, in *Nature for Society* scenarios, we observed that the restoration of connectivity had a mean value of 0, and negative contributions towards the restoration of throphic complexity and natural disturbance with a mean value of −0.07 and −0.18 respectively. In *Business-as-usual* scenarios only negative contributions towards rewilding components were observed (Fig. 4).

Positive effects on the NCPs components were found more frequently in all the NFF archetypes. For instance, under the *Nature for Nature* scenarios, we observed mean values of 0.43 for 0.18 regulatory and 0.20 non-material NCPs. Moreover,

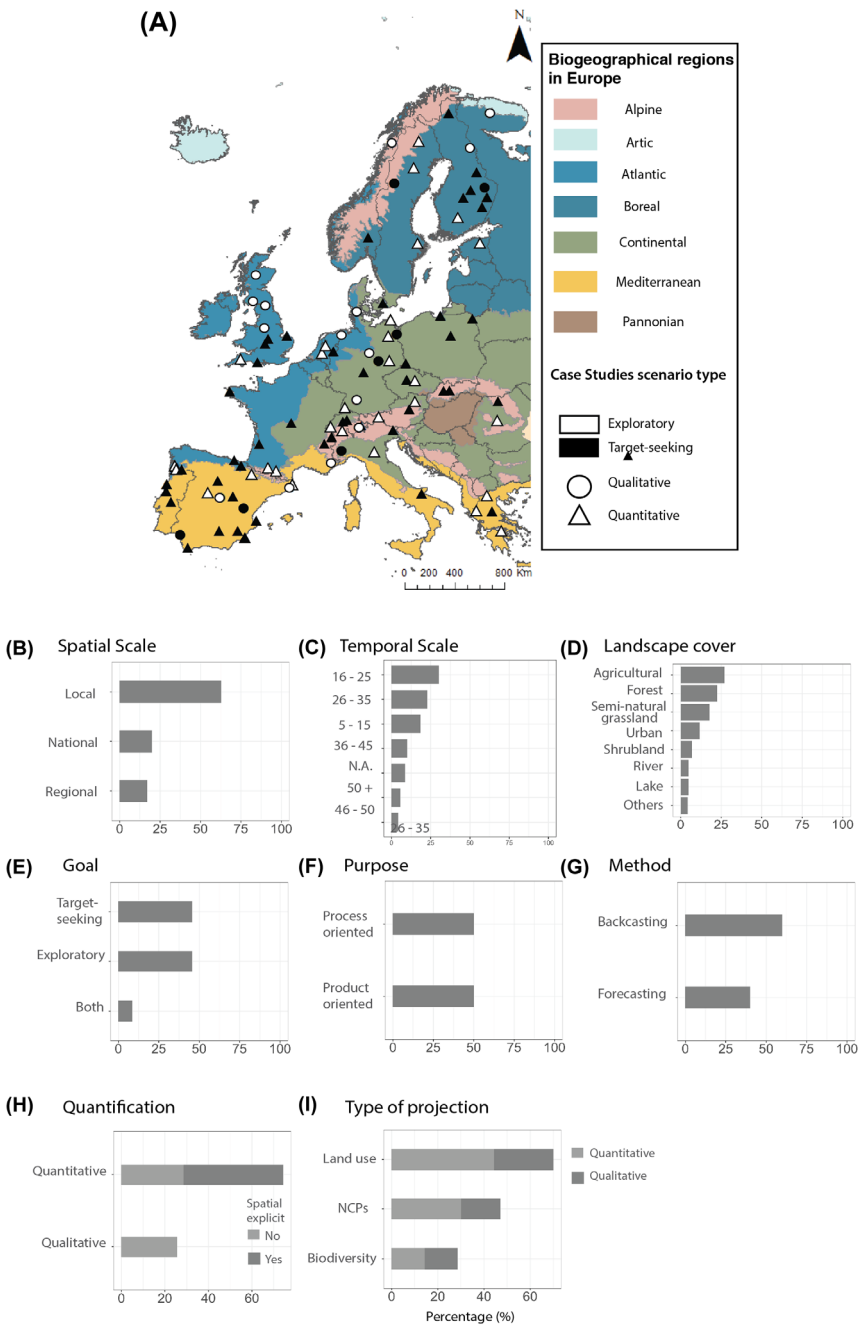


Figure 2. Main characteristics of the participatory scenarios in Europe analysed in this study. Each bar plot represents the percentages (%) of studies reviewed. These characteristics are: (A) locations of the studies, overlayed on the map of the biogeographical regions in Europe (EEA 2016); spatial scale (B); temporal scale (years) (C); and the land cover type (D) of the case study. The goal (E) is defined as the original motivation of the study and its purpose (F) defined by the project objective. The methods (G) refers to either backcasting or forecasting scenarios. Finally, we present information about the data treatment and the type of projections by categorizing the quantification methods (H) and the scope of the projection (I) made during the scenario development process.

we found mostly positive contributions under the scenarios of *Nature for Society* with mean values of 0.44 for non-material, 0.26 for material and 0.22 for regulatory NCPs. *Nature as Culture* had the highest overall positive effect for non-material contributions with the highest recorded mean of 0.45, followed by the material NCPs with a mean of 0.21 and regulatory NCPs with a mean of 0.18. As for negative effects, these were only recorded for the *Business-as-usual* scenario for the regulating and non-material NCPs with mean values −0.28 and −0.29 of respectively (Fig. 4).

Discussion

Most of the scenario narratives developed in Europe during the last two decades addressed effects of land use on nature

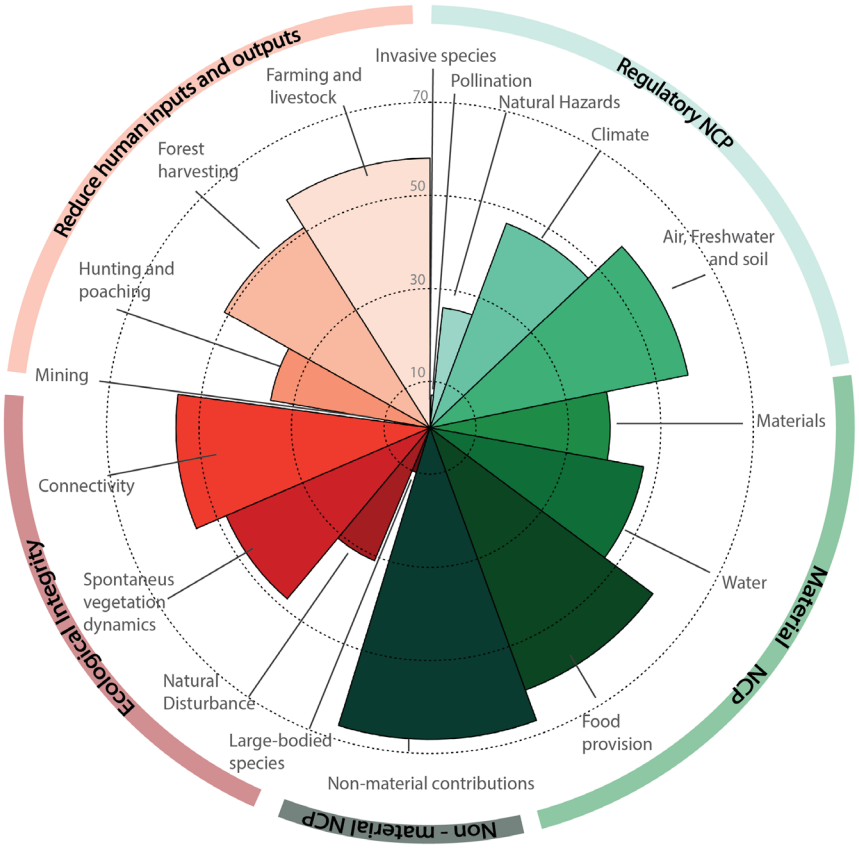


Figure 3. Number of studies that included in their scenarios storyline's elements of regulatory, material and non-material nature contributions to people (NCPs), in shades of green, and components of rewilding in terms of ecological integrity and reduction of human outputs and inputs, in shades of red. Detailed information of the components is provided in the Supporting information.

contributions for people and focused on the provision of material and regulatory services such as food production and water regulation. In contrast, scenarios including rewilding components were rare. Where elements of restoration were addressed, such as connectivity through green corridors, those were associated with changes in NCPs. In the *Nature for Nature* archetypes positive effects on the connectivity were associated with the increase of regulatory services. For instance, in a participatory scenario in Doñana (Spain), the restoration of landscape connectivity was planned with the aim of providing nature contributions to people such as water regulation and eco-tourism, while the outcomes for critical ecosystem attributes that depend on connectivity like natural disturbances and the trophic complexity were not explicitly considered (Palomo et al. 2011).

The prioritization of regulatory and material NCPs in the scenario narratives often responded to the need to secure the supply of these NCPs in an uncertain future of nature (Heikkinen et al. 2010, Plieninger et al. 2013, Rosenberg et al. 2014, Accastello et al. 2019). For example, in the Gällivare area (Sweden) a town which is going through a sectorial transformation from mining towards alternative economic activities, stakeholders were confronted with scenarios that explored futures in which nature conservation is prioritized versus scenarios where wood extraction or tourism takes place. The preferred scenarios included multifunctional mosaic landscapes guaranteeing the use of natural resources such as wood extraction, grazing lands and agriculture. However, the designation of areas for restoration and conservation was not the main target in the narratives but rather resulted from the designation of areas where the extraction of natural resources was not possible (Accastello et al. 2019). This illustrates that scenarios often consider positive effects of restoration on biodiversity as an indirect consequence, thus missing the full potential of restoration planning. As a result, we consistently observed a clear gap in incorporating practices of restoration in the participatory scenarios that could improve ecosystem complexity, like the restoration of natural disturbance regimes and the trophic complexity of an ecosystem. This may have resulted from attempts (explicit or not) to minimize confronting stakeolders with restoration actions that may exacerbate conservation conflicts: for example, the recovery of megafauna could give rise to complex human–wildlife conflicts (Heikkinen et al. 2012, Killion et al. 2020).

Facilitating the coexistence of humans with wildlife remains a major challenge to overcome, as many interventions often benefit one goal at the expense of the others. However, neglecting the need to integrate such critical ecosystem components in the scenario narratives likely leads to the implementation of counterproductive actions that ignore the

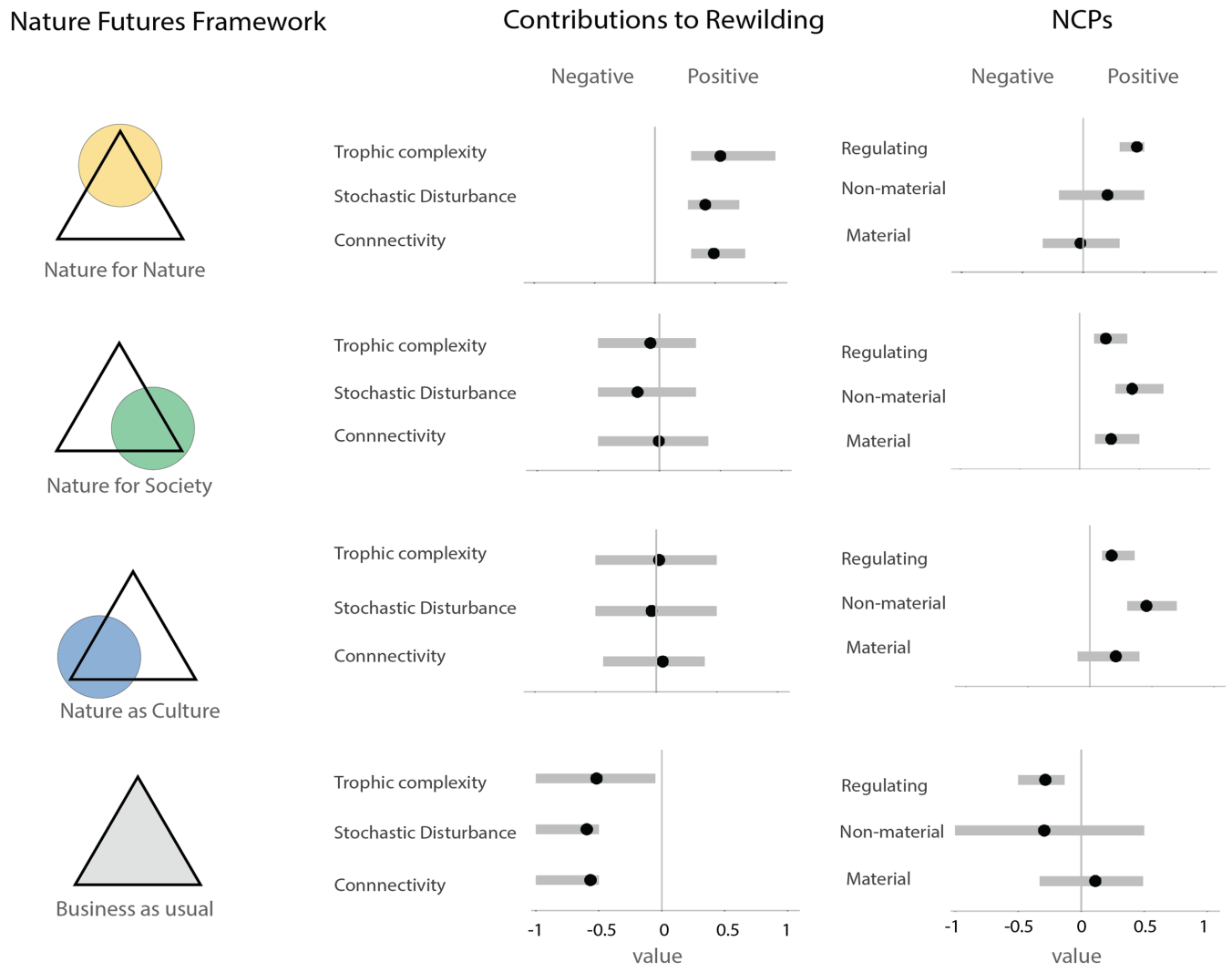


Figure 4. Evaluation of the positive and negative contributions to rewilding and nature contributions to people (NCPs) under different scenario narratives of the nature future framework from 246 scenarios. The contributions to rewilding represent the key elements measured for the ecological status of the system, namely: trophic complexity, stochastic disturbance and connectivity. The NCPs were subdivided into regulating, non-material and material contributions to peoples. Both contributions to rewilding and NCPs were represented in a bar plot, with the arithmetic mean represented by a black circle, and in grey the upper and lower quartiles from 246 scenarios. The values refer to the assigned score to the different components were 1 if the scenario mentioned positive effects, −1 for negative effects. For detail information of the scores see the Supporting information.

potential synergies and trade-offs between nature and people (Rosa et al. 2017, Killion et al. 2020). This, in turn, reflects the disconnection between the needs of society and efforts to restore biodiversity, where the incorporation of approaches for restoration and conservation has been rarely prioritized. The fact that human well-being and biodiversity are seen as separate components makes it more difficult to implement measures that generate the transformative change necessary to meet the EU biodiversity strategy for 2030 and the global Sustainable Development Goals (SDGs). For instance, to ensure that 30% of European protected species and habitats are in favorable conservation status or show positive trends by 2030, it is critical to explore, and project, the contributions of local and regional-scale restoration efforts to large-scale conservation targets, with an emphasis on the co-benefits between ecological (e.g. rewilding) and social perspectives (e.g. NCPs) (Fischer et al. 2020).

We observed an increase in the application of target seeking scenarios for policy design and implementation as compared to previous reviews on participatory scenarios (Oteros-Rozas et al. 2015, Killion et al. 2020). More specifically, the scenarios have been used as policy-support tools in cases of high conflict risks over the prioritization of different land uses, for instance, the designation of priority areas for conservation over areas for agricultural intensification (Gielczewski et al. 2011, Palomo et al. 2011, Lamarque et al. 2013, Haatanen et al. 2014). However, we found that many of the scenarios project in a non-quantitative way the possible

outcomes on society and very few aimed to project in a spatially-explicit manner the effects of landscape change on the restoration of ecosystems and conservation of biodiversity.

Indeed, an important process for biodiversity restoration is the development of quantitative scenarios that can inform adaptive management practices. Such scenarios may help to develop model-supported tools that facilitate measuring rewilding and restoration progress at landscape scales. However, our systematic review showed that these are still rare. We found that most participatory scenarios where not used to develop such tools but were rather focused towards building process-oriented outcomes. The latter approach was often used to foster social learning, mitigate conflicts and facilitate the co-production of knowledge in the communities (Oteros-Rozas et al. 2015). Even though this is important to empower local communities, it is of limited utility when projecting how restoration actions may contribute to large-scale ecological targets. Furthermore, the lack of quantitative models associated to the scenarios subsequently hinder the monitoring and evaluation of the implementation of scenario outcomes and undermines our capacity to up-scale successful restoration approaches (Hanspach et al. 2014, Malek and Boerboom 2015, Dupont et al. 2016, Jorda-Capdevila et al. 2016, Karner et al. 2019).

We found that most of the studies respond to management needs at a local scale, such as the management of national parks, NCPs in rural settings and the management of water resources. Although some studies have successfully identified scenarios at multiple scales (Houet et al. 2017, Karner et al. 2019), we found that these are still a minority in the land-use and biodiversity literature. This is because, often, participatory scenarios address conservation problems associated to local socio-economic dynamics (Rosa et al. 2017, Pereira et al. 2020). Therefore, the lack of integration between local management practices and the needs of the local communities within regional and national plans and policies still represents a challenge. Future planning of participatory scenarios should aim at incorporating multiscale processes. Multiscale scenarios not only allow us to replicate and evaluate scenario outcomes over time but also help to identify initiatives that can be translated into multiple scales (Rosa et al. 2017). Hence, generalizing the construction of spatially explicit scenarios in participatory approaches and the model projections that can be derived will help reducing the gap between restoration planning (most often focused on local ecosystems and human communities) and large-scale nature conservation targets (including national, supranational and global targets) (Karner et al. 2019).

A synthetic perspective of rewilding, NCPs and the Nature Futures framework

Our approach to the classification of the scenarios based on the Nature Futures framework allowed to analyse and synthesise the pluralistic views of the scenario narratives. This represents a major advantage over other frameworks such as SSPs that focuses more on the socio-economic dynamics of society. There is high potential for the Nature Futures archetypes to develop restoration scenarios that reflect a plurality of perspectives according to the values of Nature for Nature, for Society and as Culture. Our synthesis study is the first to analyze a disparity of scenario narratives to match elements of rewilding and restoration of NCPs with these Nature Futures archetypes (Fig. 4).

Most of the scenario narratives accounting for positive effects of rewilding coincided with the *Nature for Nature* archetype. This is consistent with previous studies that advocated for allocating large, connected areas with reduced human intervention to promote the recovery of biodiversity and functional ecosystems, for example, as offered by abandoned lands (Pereira and Navarro 2015, Svenning 2020). We found that the creation of green corridors for enhancing connectivity (Van Berkel and Verburg 2012, Martinez-Sastre et al. 2017, Perez-Soba et al. 2018) and an increase of strictly protected areas for restoring trophic processes and natural dynamics (Haatanen et al. 2014, Palomo et al. 2017, Accastello et al. 2019) were most cited in narratives creating space for nature. However, tradeoffs were often mentioned in scenarios that prioritized rewilding, such as reduction of perceived cultural value and conflicts over land use prioritization (Hanspach et al. 2014, Palomo et al. 2017, Accastello et al. 2019, Vannier et al. 2019).

In scenarios classified as *Nature for Society* and *Nature as Culture*, positive effects were largely related to material and non-material NCPs and less so with rewilding components and regulatory services. This is the case with the adoption of sustainable agricultural and forestry practices that, in parallel, strengthen the local economy and the construction of a strong local identity (Van Berkel and Verburg 2012, Oteros-Rozas et al. 2013, Haatanen et al. 2014). In general, these scenarios were positively received by the communities , especially in areas undergoing land abandonment, where they were valued as ways of counteracting negative trends in local economies (Vacquie et al. 2015). In scenarios of *Nature as Culture*, rewilding coincided with land abandonment, which in turn was negatively depicted as a loss of cultural landscapes and local identity, and rural population declines (Van Berkel and Verburg 2012, Hanspach et al. 2014). However, the most negative outcomes towards rewilding components and NCPs were observed in the *Business-as-usual* scenarios. These scenarios were characterized by a lack of nature conservation strategies, exposing conservation areas to pressures of increased housing demand, agriculture extensification due market liberalization and tourism expansion (Tzanopoulos et al. 2013, Jorda-Capdevila et al. 2016, Martinez-Sastre et al. 2017, Gómez Martín et al. 2020).

Our results revealed that participatory scenario studies often assigned positive outcomes of rewilding components and NCPs into separate scenario narratives, therefore failing to identify key co-benefits that are needed to address – and mainstream – restoration across scales. An even greater challenge is incorporating the many concepts, values and interrelations associated with nature in the scenarios (Pascual et al. 2021). We recommend strengthening efforts in this direction by identifying co-benefits in participatory scenario development for restoration, such as seeking common elements

required to meet goals in all three nature future archetypes. In addition, we think that landscape scenarios should embrace spatially explicit scenario modeling as a benchmark for translating scenario outcomes into measurable contributions to large-scale restoration and conservation targets.

Conclusion

Overall, our results highlight two major gaps to be addressed in future participatory scenario planning. Firstly, there is a paucity of spatially explicit data and outcomes, with scenarios failing to transform their results into quantitative information needed for monitoring progress and for assessing the contributions of restoration across scales. Secondly, the participatory scenarios identified in the systematic review tended to be biased towards a stronger focus on nature contributions to people and human well-being. As a result, co-benefits for people and nature were systematically underrepresented and insufficiently evaluated, which compromises our capacity to deliver comprehensive information for effective biodiversity management and policy. In order to address these gaps, novel and more diverse scenario narratives are needed that explore co-benefits, for example, between rewilding and other value visions for nature. Although our synthesis showed that the Nature Futures framework can contribute to capturevery different visions and outcomes of restoration, there is still a need to explore areas of synergies and intersection across its different archetypes, for example, overcoming the limits of associating rewilding to a purely *Nature for Nature* perspective, or some material and regulatory NCPs to a purely *Nature for Society* archetype. Advances in these directions are necessary for addressing restoration targets in complex social–ecological systems. In so doing, we can begin to envision positive future scenarios where biodiversity conservation and human well-being are better interlinked and fostered during the UN Decade on Ecosystem Restoration and beyond.

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Data is available from the Dryad Digital Repository: <https://doi.org/10.5061/dryad.n5tb2rbwh> (Quintero-Uribe et al. 2022).

Supporting information

The supporting information associated with this article is available from the online version.

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