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Scenario framework for the Trans-European Nature Network (TEN-N)

D5.1 Scenario framework for TEN-N, translation of NFF storylines into indicators and scenario settings

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NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

Prepared under contract from the European Commission.

Project acronym:	NaturaConnect
Project full title:	NaturaConnect - Designing a resilient and coherent Trans-European Network for Nature and People
Grant agreement number:	101060429
Start of the project:	1 July 2022
Duration:	48 months
Project coordinators:	International Institute for Applied Systems Analysis (IIASA) and Martin-Luther Universität Halle-Wittenberg (MLU) naturaconnect.eu
Scientific coordinator:	Piero Visconti, PhD, IIASA
Type:	HORIZON Innovation Actions
Call:	HORIZON-CL6-2021-BIODIV-01

Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

Project reference number	101060429
Project title	NATURACONNECT - DESIGNING A RESILIENT AND COHERENT TRANS- EUROPEAN NETWORK FOR NATURE AND PEOPLE

Deliverable title	Scenario framework for TEN-N, translation of NFF storylines into indicators and scenario settings
Deliverable number	D5.1
Contractual date of delivery	30.06.2023
Actual date of delivery	31.08.2023
Type of deliverable	R — Document, report
Dissemination level	PU - Public
Work package number	WP5
Institution leading work package	VUA
Task number	5.1
Institution leading task	US
Author(s)	Claudia Fornarini, Alessandra D'Alessio, Jeremy Dertien, Néstor Fernández, Francisco Moreira, Anandi Sarita Namasivayam, Louise O'Connor, Henrique M. Pereira, Peter Verburg, and Carlo Rondinini.
EC project officer	Christophe Coudun

Deliverable description	The report will document the methods to produce scenarios and the storylines of these scenarios using the IPBES Nature Futures Framework.
Keywords	Nature Futures Framework, narratives, nature futures storylines

Acknowledgements

We are deeply grateful to all participants who attended the 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop and 'Nature Future Scenarios for a Resilient Trans-European Nature Network (TEN-N)' webinar, and provided significant input to the development of the Nature Futures narratives.

The authors wish to thank NaturaConnect project members Jutta Beher, Maria Hällfors, Martin Jung, Maria Paniw, Laura Quintero-Urbe, Piero Visconti and Martina Marei Viti, who moderated stakeholder dialogue sessions during the workshop and took notes that contributed to the drafting of this report.

Further thanks to Matea Osti, Marit Schnepf and Miradona Krizbai for their contribution to the organisation of the stakeholders' events and for their review of this report. We also thank Gabriele Rada for the illustrations of the three Nature Futures narratives.

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Abbreviations

CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
EC	European Commission
ES	Ecosystem services
EU	European Union
GLOBIOM	Global Biosphere Management Model
IIASA	International Institute for Applied Systems Analysis
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
KBA	Key Biodiversity Area
NaC	Nature as Culture
NBS	Nature-based Solutions
NCP	Nature's Contributions to People
NF	Nature Futures
NFF	Nature Futures Framework
NfN	Nature for Nature
NfS	Nature for Society
PAC	Paris Agreement Compatible Scenarios for Energy Infrastructure
PA	Protected Area
PMC	NaturaConnect Project Management Committee
RCPs	Representative Concentration Pathways
RES	Renewable Energy Sources
SCP	Systematic Conservation Planning
SSPs	Shared Socio-Economic Pathways
TEN-N	Trans-European Nature Network

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Glossary

Active restoration	Restoration practice that eliminates the source of disturbance and implements strategies to accelerate recovery and overcome obstacles to that recovery (Holl and Aide, 2011).
Ecological corridor	A defined geographical space that is governed and managed over the long term to conserve or restore the effective flow of natural processes between species, habitats, ecosystems, or protected areas (Hilty et al., 2020).
Farm to Fork	The Strategy included in the European Green Deal that promotes the adoption of innovative techniques (e.g., biotechnology), advisory services, financial instruments and research, which contribute to make food systems fair, healthy and environmentally friendly (EC, 2020 a). One specific target of the Strategy is an increase in areas of organic farming to cover at least 25% of the EU's agricultural land by 2030 (Purnhagen, 2021).
Green bridge	Infrastructure that fosters connectivity between natural environments and reduces the barrier effect for wildlife, allowing for the recolonisation of these species in rewilding landscapes.
Green and Blue Infrastructure	An interconnected network of natural and semi-natural areas with other landscape features e.g., green roofs, retention and detention ponds, re-naturalised and de-culverted rivers, swales and 'bioswales', or rain gardens (Abbott et al., 2013; Ghofrani et al., 2017), designed and managed to deliver a wide range of services (e.g., improvement in air and water quality, space for recreation, climate mitigation and adaptation), while also enhancing biodiversity (EC, 2019).
Intensive farming	Agricultural practice that is concerned with productivity and uses a prominent level of inputs (e.g., chemicals, fertilisers, pesticides and growth regulator) and energy to achieve it (Someus, 2009).
Irreplaceable site	Essential and unique area for achieving conservation targets (Baisero et al., 2022).
Land sharing	A strategy where less land is set aside specifically for conservation, but less intensive production techniques are used to keep some biodiversity throughout agricultural land (Fischer et al., 2013; Green et al., 2005).
Land sparing	A strategy where some land is set aside for conservation while other land is used intensively to produce agricultural commodities (Fischer et al., 2013; Green et al., 2005).
Key Biodiversity Area	Areas contributing significantly to the global persistence of biodiversity, in all terrestrial, freshwater and marine ecosystems (IUCN, 2016).
Narrative	A way to describe diverse worldviews and value types, holding qualitative elements. From this descriptive framework, quantitative exploratory scenarios can be formulated (IPBES, 2023).
Natura 2000 site	Network of core breeding and resting sites for rare and threatened species, and for some rare natural habitat types, which aims to protect

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	Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive (EC, 2008).
Natural ecological succession	The process by which juvenile plants and coppice that have established naturally replace plants which have died or have been extirpated (Brown, 2004).
Nature-based Solutions (NBS)	Actions that are 'inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience' (Connecting Nature, 2020). These solutions bring more diverse natural features and processes into cities, landscapes and seascapes, thus providing multiple benefits for biodiversity (Connecting Nature, 2020).
Nature's Contributions to People (NCP)	Both positive and negative contributions of living nature (i.e., diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to the quality of life for people. Beneficial contributions include, for example, food provision, water purification, flood control and artistic inspiration. Detrimental contributions include, for example, disease transmission and predation that damages people or their assets. Many NCP may be perceived as benefits or detriments depending on the cultural, temporal, or spatial context (IPBES, 2019).
Nature Futures Framework (NFF)	A heuristic that captures diverse, positive values for human–nature relationships in a triangular space where at each of the vertices three main ways of valuing nature are positioned (Nature for Nature - NfN; Nature for Society - NfS; and Nature as Culture - NaC – see Figure 1). The NFF builds on the three values of nature (intrinsic, instrumental and relational values, respectively) identified by the IPBES and repurposes them to make them actionable for the modelling and scenarios community. The NFF triangle illustrates how it is possible to emphasise a complex mixture of values allowing for a plurality of perspectives to be held in various times, contexts and spaces (Pereira et al., 2020).
Organic farming	Integrated production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles and soil biological activity without the use of synthetic farm inputs (e.g., pesticides, fertilisers and medicines) and genetically modified organisms (Joint FAO/WHO, 2007; Kutama et al., 2013; Warra and Prasad, 2020). It emphasizes the use of natural and traditional inputs (i.e., minerals and products derived from plants) such as green manure, compost manure, crop rotation and other cultural practices to eliminate pests and manage diseases (Kutama et al., 2013; Warra and Prasad, 2020).
Passive restoration	Restoration practice that allows natural succession to occur in an ecosystem after removing a source of disturbance (Vaughn et al., 2010).
Permaculture	A holistic approach to agriculture that provides for human needs (high-quality food, fibre, fuel, medicine and building materials) while enhancing the ecosystems and communities from which these derive; it offers a set of ethics and principles and a means of integrating social and ecological processes in a way that is grounded in the local context (International Symposium on Agroecology, 2018).
Precision farming	An innovative method of cultivating lands based on the optimised management of inputs in a field according to actual crop needs. It involves data-based technologies, including satellite positioning systems like GPS, remote sensing and the Internet, to manage crops and reduce the use of fertilisers, pesticides and water (EurActive, 2015).

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Protected Area	A clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values. Protected Areas include nationally designated sites and Natura 2000 sites (IUCN, 2008).
Regenerative farming	Holistic farming systems that, among other benefits, improve water and air quality, enhance ecosystem biodiversity, produce nutrient-dense food, and store carbon to help mitigate the effects of climate change (CBF, 2023).
Representative site	Protected areas that protect viable areas and systems covering the full range of biodiversity within an ecologically defined region. This is achieved through the inclusion of the full range of natural terrestrial and aquatic ecosystems, special habitats and populations, and geological and physiographical sites of importance within the site (Elliot et al., 2017).
Revitalisation	A process that involves promoting the revival of traditional practices (i.e., practices of the past) as an alternative to industrialised agriculture, and that also promotes resilient cultivation systems as well as social relations. It can serve as a means of increasing food security and reversing the spread of pest development caused by increased monoculture (Dahlin and Svensson, 2021).
Rewilding	A form of ecological restoration with an emphasis on reducing human control of ecosystems and relying on ecological processes to achieve complex self-regulating ecosystems. Rewilding trajectories encompass the increase in trophic complexity, the dispersal capacity of organisms and the recovery of natural stochasticity regimes (Perino 2019; Svenning 2020).
Scenario	Plausible and often simplified descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships (Millennium Ecosystem Assessment, 2005; Pereira et al., 2020).
Stepping stones	A series of small landscape features that help long-distance ecological flows, such as gene flow, and the connectivity of populations.
Vision	A desirable state in the future and therefore, a part of scenarios (the probable future states), demarcated from predictions (future states) and pathways (that lead up to the vision) (Pereira et al., 2020; Wiek and Iwaniek, 2014).
Wilderness	Large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition (Casson et al., 2016). The definition of wilderness is different from wildness which is the broader category: all instances of wilderness are instances of wildness, while all instances of wildness are not instances of wilderness (Chapman, 2006; Perino et al., 2019).

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Executive summary

A key goal of the EU Biodiversity Strategy for 2030 is the **design of a connected Trans-European Nature Network (TEN-N), that helps to build a coherent and resilient network of protected areas across Europe**. The TEN-N will need to consider and integrate societal perspectives on future biodiversity protection in Europe, accounting for multiple values and perspectives of nature. The NaturaConnect project, through a process of co-design with stakeholders, is developing **narratives on future nature protection in Europe using the Nature Futures Framework (NFF).** In this framework. three value perspectives of nature are presented at each corner of a triangle: Nature for Nature, Nature as Culture, and Nature for Society. By using this framework, NaturaConnect aligns with global efforts on scenario development auspicated by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

This report outlines the development of scenario narratives for Europe of the NaturaConnect project. The development of the narratives considered the global and European policy context as a starting point, and included a stakeholder engagement process conducted to elicit stakeholders' preferences and visions in relation to future nature conservation and management in Europe. In detail, the process of developing the narratives included the following steps:

1. Identification by the NaturaConnect research team of the socio-economic development pathways that are compatible with the achievement of the EU Biodiversity Strategy for 2030 and the CBD 2050 vision.
2. Participatory development of the NFF visions and components of the narratives during a three-day in-person stakeholder workshop, eliciting diverse perspectives on seven relevant topics for conservation planning.
3. Identification of the boundaries provided by the global and European goals, desk analysis and synthesis of the outcomes of the workshop, and drafting of the NFF narratives by the research team.
4. Organisation of an online participatory webinar, to elicit further inputs from a broader community of stakeholders.
5. Development of the second draft of NFF narratives.
6. Internal review by the NaturaConnect Project Management Committee.
7. Refinement of the narratives and identification of a preliminary set of indicators and settings to translate the narratives into quantitative scenarios and models for planning the TEN-N.

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We summarised the results in the form of three novel “Nature Futures” narratives for Europe. These narratives present contrasting perspectives and priorities for seven themes:

- **Protected areas,**
- **Connectivity and Restoration,**
- **Forestry,**
- **Freshwater ecosystems,**
- **Urban system,**
- **Agriculture,**
- **Energy.**

These topics are key to building a more positive future for nature and people. Besides specificities for each narrative, we also identify commonalities across the three perspectives, including macroeconomic trend assumptions, biodiversity strategic goals of the European Union and shared solutions that are necessary to achieve any positive nature future. The NaturaConnect Nature Futures narratives are outlined below.

Nature for Nature

The **Nature for Nature** narrative **centres on the intrinsic value of nature,** independently of the benefits to people. In this narrative, natural areas under strict protection are set to drastically reduce human intervention in ecosystem processes. By reducing the sprawl of new infrastructures and the demand for biofuel, whose production requires large areas, there is more space for wilderness. Protection of nature primarily aims to achieve the undisturbed functioning of self-regulated ecosystems, instead of seeking to manage nature for material and non-material benefits that people may get. Approaches such as non-management, rewilding (the ecological process of letting nature take its course through reducing long-term management), the improvement of resilience to disturbances and the restriction of extractive uses, are key to this scenario wherever possible.

Figure 1: A possible representation of the Nature for Nature narrative. © NaturaConnect

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Nature for Society

The **Nature for Society** narrative focuses on the **utilitarian benefits** and **instrumental values provided by nature**, thus **ecosystems are managed to prioritise and enhance the provision of Nature's Contributions to People (NCP)**. Natural areas are integrated with a matrix of human land use, and multifunctional and multiscale landscapes are sustainably managed. Green infrastructure and ideas such as Nature-based Solutions are key components of cities and other landscapes. Protected areas emphasise both biodiversity conservation and ecosystem service delivery. Society pursues sustainable development, adopting win-win solutions for nature and people in different sectors.

Figure 2: A possible representation of the Nature for Society narrative. © NaturaConnect

Nature as Culture

The **Nature as Culture** narrative focuses on the **relational values between nature and people's culture (e.g., sense of place, participation, stewardship, spirituality, reciprocity)**, strengthening the **personal connection that humans have with nature**. Emphasis is given to traditional land use practices and experiences that connect people to specific landscapes (e.g., Farm to Fork initiatives, wine routes, transhumance of livestock, biodiversity-friendly farming, pilgrimage routes, hiking and enjoyment of nature); consequently, the belief systems and behaviours adapt to a society where nature-centred education and lifestyles are a priority. The connection that people feel towards the environment is strengthened by an increase in community-based management initiatives. Emphasis is given to the heterogeneity of cultural landscapes across Europe. Overall, the land sharing principle prevails more than in the other perspectives, by integrating nature within human managed systems.

Figure 3: A possible representation of the Nature as Culture narrative. © NaturaConnect

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The narratives will serve as a basis to investigate how land use and nature conservation scenarios can be integrated to achieve the NaturaConnect aim of designing a coherent TEN--N for nature and people. NaturaConnect will use CLUMondo, a land use change model, to translate each narrative into a spatially explicit land use change scenario aligning macroeconomic demands with the existing GLOBIOM model outputs for the Shared Socio-Economic Pathways (SSPs). Specifically, the macro-economic context and demands projected in SSP1 and RCP2.6 will be used as a starting point (Table 1), as these align best with the positive future envisioned in all the NFF scenarios in terms of a high commitment to sustainable development, and strong climate change mitigation measures. The assumptions of SSP1 and RCP2.6 will be spatialised following the specifics of each narrative, thus producing alternative realisations according to the different societal preferences represented by the three corners of the NFF triangle.

Table 1: Suggested NFF-SSP matrix within which to define model specifications.

European NFF/Global contextual scenarios	RCP2.6	RCP7
SSP1 + NFF1: Nature for Nature	Positive and optimistic outlook, with nature's intrinsic value having priority.	Combination not possible.
SSP1 + NFF2: Nature for Society	Positive and optimistic outlook, with nature's contributions to people having priority.	Combination not possible.
SSP1 + NFF3: Nature as Culture	Positive and optimistic outlook, with nature's cultural value having priority.	Combination not possible.
SSP3 (standard elaboration for Europe)	Combination not possible.	Robustness check: Stressed land use and stressed climate effects in context of TEN-N.

The narratives will be used by NaturaConnect also to develop specific **settings for connectivity** in terms of priorities for conserving and restoring functional and structural connectivity, and priorities for connecting protected areas (PAs), in the three corners of the NFF. For example, the conservation and restoration of structural connectivity will prioritise roadless areas in the Nature for Nature TEN-N, the development of Green and Blue Infrastructure connecting peri-urban landscapes in the Nature for Society TEN-N, or enhancing landscape mosaics and hedgerows in the Nature as Culture TEN-N. The narratives

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will shape the **settings for spatial conservation planning**, to identify opportunities and constraints for conservation and restoration, suitable habitats within the future distributions of species and ecosystems, and conservation priorities for the 30% conventional PAs and 10% strictly PAs (within the 30%), according to the main strategic objectives of the EU Biodiversity Strategy for 2030.

Finally, in Annex 1, we provide a table of **indicators to track the scenarios across the different topics; this table** will be further developed during the lifetime of the project.

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1. Introduction

1.1. The Nature Futures Framework

Scenarios for global environmental assessments are recognised as powerful tools to explore how different pathways of societal development and policy choices could affect nature and ecosystem services (ES) provisioning (Pereira et al., 2020). However, most current scenarios are not apt to explore the role of nature and related policies in driving human/society development (IPBES, 2016; Pereira et al., 2020; Saito et al., 2019). Indeed, these scenarios only assess the impacts of direct and indirect drivers on a few aspects of nature and NCP, often highlighting negative trends and impacts, rather than identifying plausible positive futures for nature and people (Lundquist et al., 2021). Moreover, in most cases they do not address drivers' linkages or feedbacks, neither considering multi-spatial scales, nor encompassing shared values, norms and policy goals for nature conservation (IPBES, 2016 b; IPBES, 2019). For example, Shared Socio-Economic Pathways (SSPs) – as used by the Intergovernmental Panel on Climate Change (IPCC) to cover plausible socioeconomic developments and emission scenarios – account for macro-scale drivers and global dynamics (demography, trade, diet, etc.) but do not detail where we protect nature, how we cultivate lands, and what types of landscapes, species or NCP we prioritise for conservation.

To address this gap, and to halt and eventually reverse the declining trend of nature and NCP (IPBES, 2019), the Expert Group on Scenarios and Models of IPBES has developed the Nature Futures Framework (NFF) as a flexible tool that embraces a plurality of perspectives on desirable futures for people and nature, where nature is at the centre and not only an outcome (Rosa et al., 2017; Pereira et al., 2020). The NFF is designed to aid the development of integrative nature-people scenarios across multiple spatial and temporal scales (Kim et al., 2023; Palacios-Abrantes et al., 2022; Pereira et al., 2020). The NFF places values that people have for nature at its core, facilitating the integration of interlinkages of socio-ecological systems across all drivers, nature, NCP and good quality of life, and the assimilation of multiple systems of knowledge across scales and sectors (Lundquist et al., 2021). In the NFF, three value perspectives of nature are presented at each corner of a triangle (Figure 4).

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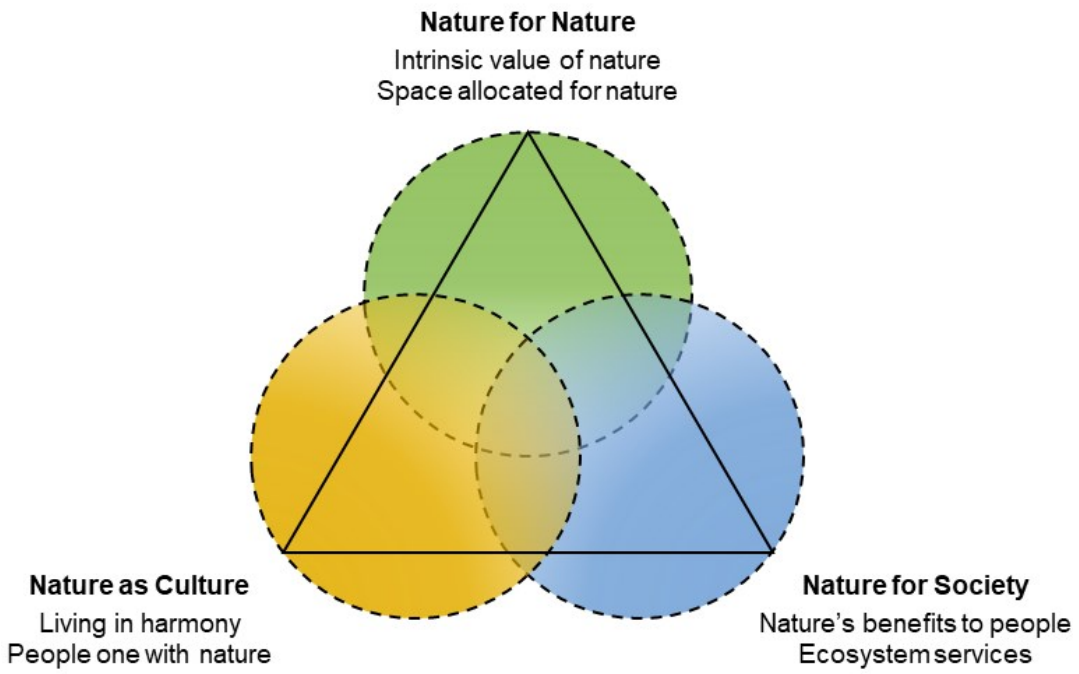

Figure 4: The Nature Futures Framework presents three value perspectives of nature in a triangle. Source: Adapted from Pereira et al., 2020.

- In the **Nature for Nature (NfN) perspective**, emphasis is placed on **the intrinsic value** of the diversity of species, habitats, ecosystems and processes that form the natural world, and on nature's ability to function autonomously and evolve**.**
- The **Nature for Society (NfS) perspective** highlights the **utilitarian benefits and instrumental values** that biodiversity and ecosystem functions provide to people and societies.
- The **Nature as Culture (NaC) perspective** reflects **indigenous and local knowledge systems and values**, and highlights the **relational values** of nature, where societies, cultures, traditions and faiths are intertwined with nature in shaping diverse socio-ecological landscapes (IPBES, 2019).

These three perspectives can be interpreted as three main axes capturing and simplifying the hyperdimensional preferences of people for nature (Kim et al. 2023, IPBES 2022). In reality, one can construct scenarios where all three perspectives are improved, but as one approaches a Pareto frontier, achievements in one perspective can only be done at the cost of other perspectives. These are the edges of the triangle, while the corners correspond to the vertices of this three dimensional Pareto frontier.

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1.2. Development of the NFF Narratives for Europe

We developed NFF narratives that were specific to the European context and coherent with the Convention on Biological Diversity's (CBD) global objectives, as well as EU policy objectives. The vision of the post-2020 Kunming-Montreal Global Biodiversity Framework, agreed by Member States of the CBD, is a world of 'living in harmony with nature' where, by 2050, biodiversity will be 'valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people' (Kunming-Montreal Global Biodiversity Framework, 2022). The European Union (EU) Biodiversity Strategy for 2030, published in 2020, sought to align with the international negotiations on the global Kumming-Montreal Biodiversity Framework and sets specific objectives to protect and restore nature by 2030 (EC, 2020 b).

One of the main strategic objectives of the EU Biodiversity Strategy for 2030 is the target to expand the current coverage of protected areas to at least 30% of land and 30% of the sea, with 10% under strict protection, to create areas that are large enough for key natural processes to take place undisturbed (EC, 2022 a). The Strategy aims to boost the coverage of Natura 2000 sites and nationally protected areas, improve their species and habitat conservation status, and contribute to addressing future environmental changes, through the development of a resilient, coherent and effective Trans-European Nature Network (TEN-N) (EEA, 2020). In addition to this, the European Parliament recently passed the European Nature Restoration Law (NRL), which aims to put 20% of EU land under restoration efforts that support the recovery of ecosystems and species towards good ecological conditions (EC, 2022 b). The Strategy includes restoration actions for pollinators, reversing the decline of their populations; for river connectivity, restoring rivers to a free-flowing state; for forest, agriculture, urban and marine ecosystems e.g., aiming to have no net loss of green urban space by 2030 and increasing the biodiversity in agricultural landscapes (EC, 2022 b).

Moreover, through the EU Farm to Fork Strategy, sustainable goals have been set in agriculture such as moving 25% of agriculture towards organic farming, reducing the use of chemical pesticidesby 50%, and of fertilizer use by 20% by 2030 (EC, 2020 a). The European Climate Law (Regulation (EU) 2021/1119) commits Member States to reach the EU's climate goal of reducing EU emissions by at least 55% by 2030 compared to 1990, through measures such as making 32% of energy sources renewable, cutting fossil fuel biomass, planting three billion trees and restoring carbon-rich ecosystems by 2030 (EC, 2023).

The above policy targets on protected areas, restoration of nature and agriculture were considered and included in the development of Nature Futures scenarios for Europe. To build

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Nature Futures narratives for Europe, plausible socio-economic development pathways were combined with stakeholders' preferences related to policy targets and visions about the role of nature in Europe. The process included the following steps, also outlined in Figure 5:

1. Identification by the NaturaConnect research team of the socio-economic development pathways that are compatible with the achievement of the EU Biodiversity Strategy for 2030 and the CBD 2050 vision.
2. Participatory development of the NFF visions and components of the narratives during a three-day in-person stakeholder workshop, eliciting diverse perspectives on seven relevant topics for conservation planning.
3. Identification of the boundaries provided by the global and European goals, desk analysis and synthesis of the outcomes of the workshop, and drafting of the NFF narratives by the research team.
4. Organisation of an online participatory webinar, to elicit further inputs from a broader community of stakeholders.
5. Development of the second draft of NFF narratives.
6. Internal review by the NaturaConnect Project Management Committee.
7. Refinement of the narratives and identification of a preliminary set of indicators and settings to translate the narratives into quantitative scenarios and models for planning the TEN-N.

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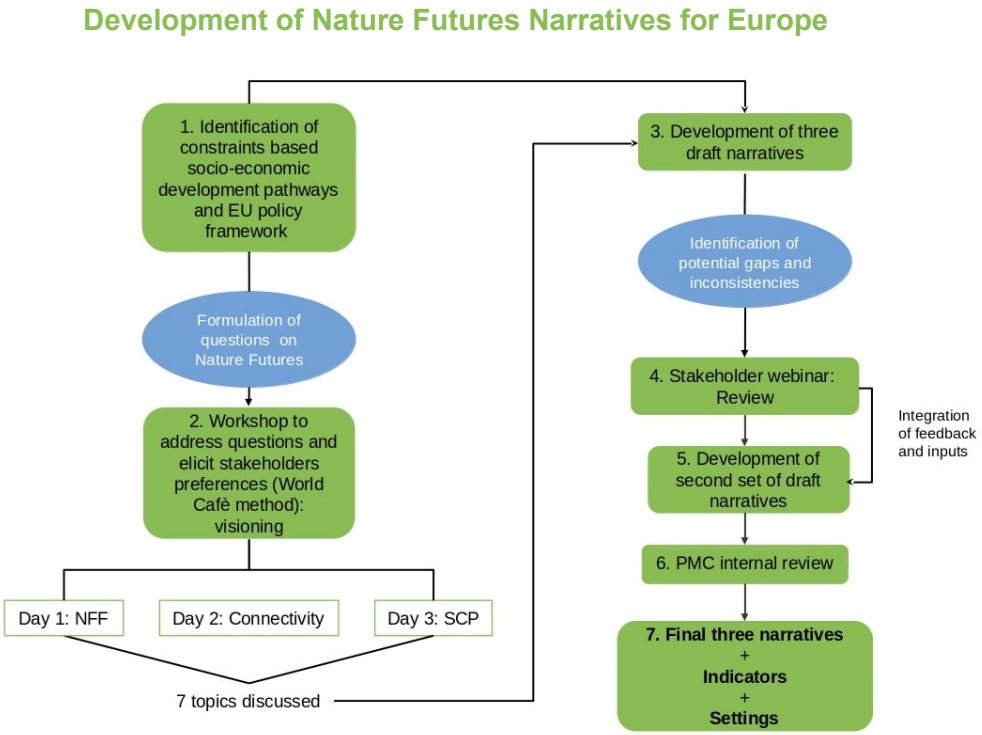

Figure 5: Development process for the Nature Futures narratives for Europe.

The socioeconomic development pathways and the EU policy framework (step 1) constituted the input to formulate questions on nature futures to be answered by stakeholders during the workshop (step 2) and the starting point of the narratives (step 3). The workshop was held over three days, Day 1 was dedicated to the Nature Futures Framework (NFF), Day 2 to connectivity, and Day 3 to systematic conservation planning (SCP), during which 7 topics were addressed (protected areas, restoration, forests, freshwater ecosystems, agriculture, urban system, energy). Stakeholders' visions and constraints were then integrated to obtain three draft narratives (step 3), which were further refined to fill possible gaps and address inconsistencies following an online stakeholder webinar (step 4). Following this, a second set of draft narratives were developed (step 5) and submitted for internal review by the NaturaConnect Project Management Committee (step 6). Following review, three final narratives, and a preliminary set of indicators and settings, were developed (step 7).

1.2.1. Workshop structure and methodology

The NaturaConnect workshop 'Designing Nature Futures scenarios to support a Trans-European Nature Network', took place in Leipzig, Germany from 8 – 10 May 2023 and involved more than 40 participants from institutions and stakeholder groups from the European environment, conservation, hunting and land-use planning sectors, as well as members of the NaturaConnect project.

The primary goal of the workshop was to elicit stakeholder perspectives and priorities on nature protection in Europe, to inform the development of European-focused narratives.

The event lasted three days: Day 1 was dedicated to exploring plural visions of Nature Futures for Europe; Day 2 to connectivity design; and Day 3 to protected areas (PAs) planning under different Nature Futures.

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Day 1: Exploring plural visions of Nature Futures for Europe

During the morning session of Day 1, the Nature Futures Framework was explained to the participants, with particular emphasis on the contrast between the three nature futures perspectives. Then, participants were divided into three groups, one per Nature Future (NF) corner, and asked to envision the future of European landscapes under the three different perspectives. The discussions were held in multiple rounds of 30 minutes each, using the World Café engagement method (Brown et al., 2010). At the beginning of a new round, participants switched to a different table to ensure everyone's contribution to all topics covering the three corners of the NFF triangle. Moderators at each NF table facilitated the conversation, showing pictures of different European landscapes and asking questions such as '*What are the main changes happening in the landscapes in this NF?',* '*What are the dominant changes in the management of agricultural areas?',* '*Why do people conserve nature according to this NF vision?',* and '*What type of Nature-based Solutions do you expect according to this NF vision?'* (Figure 6).

In the afternoon session of Day 1, participants discussed their visions in relation to the following topics: Agriculture, Energy, Urbanization, Forest management and Freshwater ecosystems. The World Café method was used once more, providing multiple conversation rounds and allowing participants to self-organise and take part in topics related to their interests (see Annexes 3, 4, 5 and 6 for detailed board pictures).

Figure 6: Group brainstorming during morning session of Day 1 of the 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop. © WWF-CEE / Hildegard Meyer

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Day 2: Connectivity

Day 2 was focused on the topic of connectivity. During the first discussion, the World Café conversation was carried out at six tables, two per NF corner. Three main questions were asked at each table: '*Why is connectivity important in this NF?'*, '*What are the main threats to preserving and enhancing connectivity?'* and '*What species, ecological processes and/or ecosystem services should be prioritised?'*. Participants rotated between tables every 20 minutes and joined the conversations in different corners for each round. A second set of questions included: '*What type of areas do we need to connect in this NF?'*, '*Where should we allocate connectivity?'* and '*What will be the impact of developing other infrastructures?*'

Subsequently, a collective brainstorming exercise was conducted to highlight the priorities, enablers and roadblocks in connectivity implementation. Participants recorded their ideas on five different boards, each referring to one policy framework or activity sector: Green and Blue Infrastructure, habitats conservation and ecosystem restoration, agroecological policies, infrastructure development and renewable energies, and species conservation (Figure 7). Participants decided the topics they wanted to discuss and for how long, before eventually switching boards (see Annexes 7 and 8 for board pictures).

Figure 7: Green and Blue Infrastructure brainstorming during afternoon session of Day 2 of the 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop. © WWF-CEE / Hildegard Meyer

Day 3: Protected areas planning

Day 3 explored protected areas planning aspects in two rounds of conversation, discussing in five tables the same questions for all corners, to stress the differences among the three value perspectives. Four main questions were asked: '*Where should strict protection take place and*

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why, in each NF?', 'What should take priority in each NF, in terms of identifying and managing the rest of the PA network?', 'Where and why would you allow some human activities inside PAs?' and '*Where and why would you have larger or smaller PAs, in each NFF corner?'* (Figure 8).

Figure 8: World Café discussion round during afternoon session of Day 3 of the 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop. © WWF-CEE / Hildegard Meyer

Figure 9: Group picture of all attendees to the 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop. © WWF-CEE / Hildegard Meyer

The moderators of each session took notes of all the answers and suggestions that emerged during the three days of discussions. After the workshop, several meetings and interviews with all moderators were organised to reach a comprehensive understanding of what was discussed at each table and to refine the notes. Then, all the inputs provided by workshop participants were analysed and classified by NFF corners. During this process, some gaps

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and inconsistencies in visions and preferences were addressed, especially for the protected areas, restoration and agriculture topics, which needed more clarification. Finally, the inputs were collated in the form of three different draft narratives, one for each of the visions of the three corners of the NFF.

1.2.2. Post-workshop webinar

To get feedback and additional inputs on the current description of the narratives, the draft narratives were presented to a broad group of stakeholders during a 2 hour online public webinar that took place on 4 July 2023, titled 'Nature Future Scenarios for a Resilient Trans-European Nature Network (TEN-N)'. The webinar brought together 115 participants, from 22 countries (Figure 10):

Figure 10: 'Nature Future Scenarios for a Resilient Trans-European Nature Network (TEN-N)' workshop participants' countries of origin. Source: Figure source: Mentimeter

The participants represented different sectors (i.e., nature conservation, spatial planning, forestry, policy and law; Figure 11).

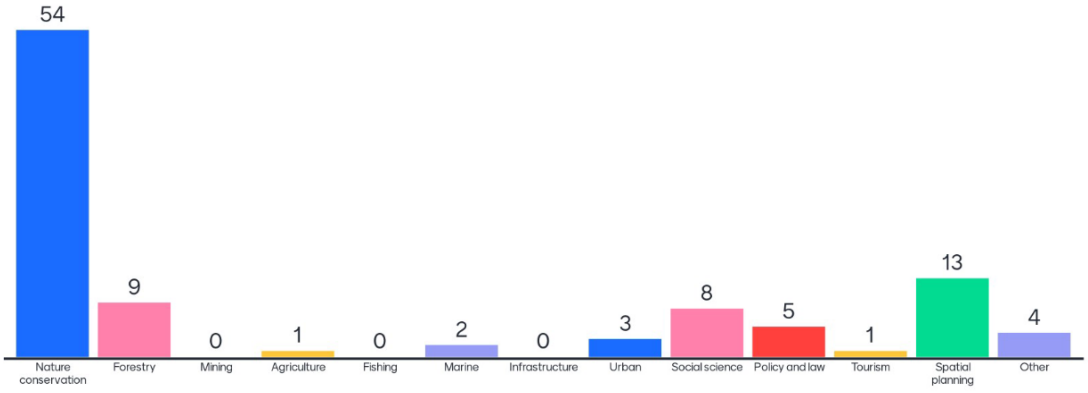

Figure 11: 'Nature Future Scenarios for a Resilient Trans-European Nature Network (TEN-N)' workshop participants' job sectors. Figure source: Mentimeter

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The nature conservation sector (54%; Figure 8), and academic and research institutions (48%; Figure 12) represented the highest number of participants:

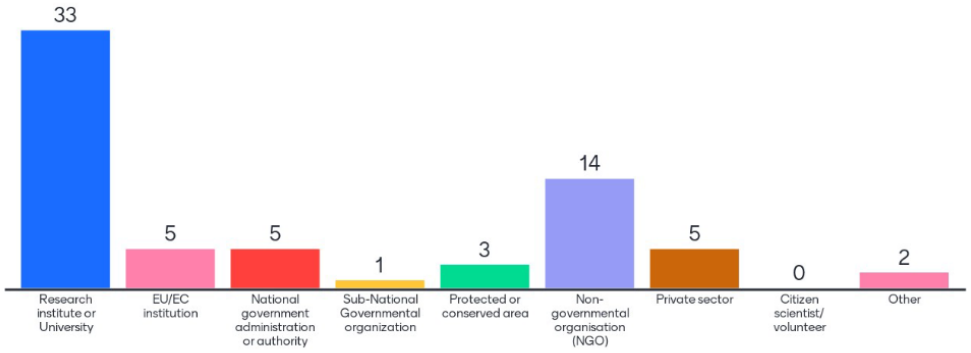

Figure 12: 'Nature Future Scenarios for a Resilient Trans-European Nature Network (TEN-N)' workshop participants' organisations. Figure source: Mentimeter

The draft narratives addressed seven different topics i.e., PAs and Species Conservation, Restoration and Connectivity, Forests, Freshwater Ecosystems, Agriculture, Urban system and Energy. The topics on Freshwater and Energy were not part of the webinar due to time limitations and inputs needed.

Each topic was first presented by scientists of the NaturaConnect consortium, explaining how they were envisioned in the draft narratives developed following the in-person 'Designing Nature Futures scenarios to support a Trans-European Nature Network' workshop. Emphasis was made on the contrasts between the three different narratives. After each topic presentation, participants answered questions (open or multiple choice) via Mentimeter (https://www.mentimeter.com/). The questions were designed to gather more input from participants on a given topic, or to help address gaps identified from the earlier in-person workshop (for the list of Mentimeter questions on Nature Futures narratives asked during the webinar, see Annex 2). After the webinar, the answers were analysed, counting the frequency of similar statements and integrating the obtained responses to produce the final narratives. A summary table, contrasting the three nature future scenarios for each topic was developed both to assist in the refinement of the narratives and to synthesize the mains results. The webinar was recorded and made publicly available as an online resource on YouTube (link).

1.2.3. Caveats

Although efforts were made to engage different sectors of society, participation from sectors was imbalanced, since most stakeholders (both in the workshop and interactive webinar) were conservation scientists and practitioners. Additionally, the dialogue among stakeholders may

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have been affected by sector-specific terminology that may have led to different interpretations of the words. The discussions were also conducted in English, which was not the native language for most participants. This could have impacted their understanding of important nuances or details in the conversations and may thus have affected the resulting content of the draft narratives. Finally, since all tables featured a moderator, discussions were guided rather than open-ended, so may have limited discussions on certain topics. To mitigate these issues, workshop notes were shared with participants following the in-person workshop in Leipzig, to ensure that participants' feedback had been accurately collected. Similarly, the post-workshop webinar was held to fill any gaps in feedback and allow for further consolidation of the narratives. Before the webinar, information on the webinar aims, as well as explanations of NFF concepts and technical terminology were made available to potential participants (link), to help them participate and contribute to the webinar more effectively.

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2. Nature Futures narratives for Europe

2.1. Commonalities across the Nature Futures narratives

All NFF scenarios reflect positive visions for nature, although they differ in terms of what is perceived as a desirable status of nature in Europe and how nature should be managed. Therefore, it is assumed that all scenarios should share the same common background in terms of socio-economic development, demography and high-ambition policies. This results in a certain amount of commonality across the NFF scenarios. Some of these commonalities have emerged through dialogue with stakeholders and are considered equally important in the narratives of positive futures for nature. 'Multifunctional' and 'multiscale' are keywords across different topics of the narratives and highlight how an integrated approach to landscape planning and management is crucial to achieving sustainability and conservation goals in Europe.

2.1.1. Underlying macroeconomic trend assumptions

Nature positive scenarios do not exist in isolation from macroeconomic developments, and the NFF scenarios need to be anchored to some underlying assumptions about macroeconomic trends and climate forcings. In NaturaConnect, we embed the NFF pathways in a broader macroeconomic context, relying on existing Shared Socioeconomic Pathways (SSPs) and Representative Concentration pathways (RCPs), described below.

The SSPs include broad projections of population changes as well as resulting demands for wood, crops, livestock, fertilisers, etc. Such macroeconomic trends can result in land-use changes from competing demands. SSP1 is the most optimistic scenario in terms of sustainable practices, focussed on overall human wellbeing and inclusive development instead of economic growth (IPCC, 2022; Riahi et al., 2017). Here, the management of the global commons is expected to improve with increasing respect for perceived environmental boundaries (IPCC, 2022; Riahi et al., 2017). This would be achieved in part by lower, more sustainable forms of consumption. Given that the NFFs are positive scenarios at their core, the macroeconomic trends showed by SSP1 are used as assumptions of all NF narratives for Europe.

The RCP scenarios indicate levels of radiative forcing based on greenhouse gas concentrations. RCP2.6 is one of the most stringent and ambitious pathways that aims to limit global temperature rise to within 2°C by 2100 (van Vuuren et al., 2011), a positive outlook best

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suited to the NFs. Thus, RCP2.6 is used here in combination with SSP1 to set the climate context in which the NFs are being envisioned.

2.1.2. Strategic goals of the European Union

The commonalities across all three NF narratives include relevant European laws and policies and in particular the EU Biodiversity Strategy for 2030, which aims to:

- Expand the EU's protected areas (including Natura 2000 sites) to 30% coverage (with one third of these areas under strict protection) by 2030;
- Ensure the conservation of species and habitats of EU and national concern, and
- Increase ecological connectivity among habitats within and outside PAs in natural and human-dominated landscapes, thus enhancing the ecological integrity and resilience of ecosystems while maintaining and fostering connections between human well-being and nature.

To achieve these goals, designing multifunctional Green and Blue Infrastructure will be crucial, for example in urban environments and other human-dominated landscapes. Coherent legislation at all scales, including enhanced use of Environmental Impact Assessments, would be refined to regulate land exploitation and soil consumption. This would ensure urban greenery and long-term sustainability with no net urban land take by 2050.

Following the European Restoration Law, river connectivity must be improved. The restoration of anthropogenic landscapes (e.g., agricultural lands, urban areas) through practices such as afforestation, fallow systems improvement, reduction in management intensity, and riparian buffer strips management is also a priority. To better identify areas of restoration concern for their potential benefit for nature, and areas of importance for biodiversity, accurate mapping of degraded natural areas needs to be developed. However, it is also important to acknowledge that some agricultural landscapes are difficult to restore given the amount of degradation, while many intensively managed areas are not easy to de-intensify because of their importance for food production. In these areas, Nature-based Solutions (NBS) may be integrated with intensively cultivated fields.

The amount of Common Agricultural Policies (CAP) subsidies need to be reformed towards sustainability. In addition, it is projected that the global human population will reach 9.3 billion people by 2050, and developing countries will be more severely affected by such an increase (UN DESA, 2019). Thus, sustainable development will be challenging if consumer demands remain focused on a meat-based diet, as dietary preferences impact the environment, in terms of land take and climate change.

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2.1.3. Common solutions across NF corners

In all three corners of the triangle, there were common ideas about specific features. These include win-win solutions that accommodate, for example, biodiversity conservation and provision of ecosystem services, as well as solutions that support the achievement of all three NFs, for example, reducing the space occupied by artificial surfaces.

Restoration

Restoration can achieve multiple goals, for example, through increasing ecosystem integrity and concurrently guaranteeing the utilitarian uses of nature (e.g., water and air purification, pollination, climate change mitigation, flood prevention) and its cultural values. For instance, restored river buffers enhance umbrella habitats/ecosystems, regulate flooding, ensure the dynamic flooding of wetlands and aquifers and expand the space for recreational activities along the rivers.

Agriculture and forests

The sustainable management of agricultural and forest landscapes could guarantee different functions simultaneously, for instance, crop residues from agricultural lands or wood residues from the furniture industry can be used to optimise biofuel production. Multifunctional agriculture systems are recognised as fundamental not only to producing food and natural materials (e.g., wood, pulp, fibre), but also to contributing to landscape and biodiversity conservation by enhancing the matrix of green infrastructure, and to facilitating activities such as agrotourism and farm education.

Sustainable forestry, which avoids clearcut, is also beneficial in terms of carbon sequestration, provides recreational areas, and supports the maintenance of biodiversity, productivity, vitality, regenerative capacity, and the provisioning, over time, of material and regulatory ecosystem services.

Urban areas

Infrastructures (e.g., highways, railways, renewable energy plants and power lines) should be as space efficient as possible to improve coexistence between humans and nature, and reduce impacts on species and ecosystems. Energetic communities (i.e., associations of local citizens, public administrations and enterprises that produce and share renewable energy) reduce the need for linear infrastructures that carry energy across landscapes. Photovoltaic panels deployed on roofs save space outside urban areas. Urban greening (e.g., tree rows, hedgerows, parks) and gardening (climbing and roof gardens, hydroponics, urban gardens) ensure environmental sustainability, material NCP and biodiversity connectivity. Zero-

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emission public transportation and bike pathways, implemented within and around cities, mitigate climate change effects and thus improve nature and human health.

2.2. Narratives

We developed three contrasting narratives for positive futures for nature matching the three corners of the NFF triangle (Table 2). While the narratives do not cover all aspects of land planning and management, they are intended to provide a sketch of how each NF may look like in a future Europe. Additional and/or more specific elements may be added to enrich the narratives or adapt them to a local context if they are in line with the overall description provided in the following sections.

Table 2: Summarised storyline information by NF topic.

Topic	NfN	NfS	NaC
Protected Areas	Emphasis on ecological integrity and resilience. Keystone species and species particularly vulnerable to human activities receive high priority.	Emphasis on NCP provisioning and associated species.	Emphasis on cultural landscapes, including high nature value farmland and associated species.
	In areas where human activities are minimised.	Located where there is NCP demand and supply.	Preferentially located near human populations.
	Activities are regulated in line with biodiversity conservation objectives.	Moderate to high tolerance for human activities/intervention related to NCP use.	High tolerance for cultural human activities.
	Strict protection is carried out in sites with high ecological integrity and PA size is important s. There is no management and no intervention	Strict protection is focused on preserving the most critical NCP . Some extractive and management activities can be allowed when contributing to protection goals.	Strict protection is applied to culturally relevant areas and to protect high cultural species. Traditional and community activities may be allowed.
Connectivity & Restoration	Ecological corridors connecting natural areas support the conservation of species and complex ecosystems.	Connected ecosystems support NCP.	Agroecological areas are interspersed with hedgerows and natural patches, and Green and Blue Infrastructure

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Topic	NfN	NfS	NaC
			is accessible to people.
	Large-scale recovery (i.e., passive restoration approach) of ecologically complex and self-sustained ecosystems (e.g., through rewilding).	Active restoration measures increase climate change adaptation, mitigation and other NCP.	Active restoration of ecosystems with cultural, educational and historical importance to support traditional uses and recreation (e.g., agroecological landscapes, rivers and wetlands).
	High importance of barrier removal to support population and genetic recovery processes.	Some barriers are removed but those that provide NCP are maintained.	Some barriers are removed to bring green areas and healthy rivers into rural landscapes and cities, but culturally relevant barriers may be kept.
Forests	Passive afforestation through natural succession enhances the structural, functional and compositional complexity of forests.	Active afforestation with native species good for carbon sequestration, timber etc.	Active afforestation with species of high cultural value.
	Land sparing approach is preferred and there is no logging in old-growth forests.	Land sharing approach: forests managed to have multifunctionality, maximising carbon sequestration, wood production and biodiversity.	Land sharing prevails with local communities managing forests to provide cultural services and the expansion of agroforestry landscapes.
	High fire risk mitigated by promoting natural grazing.	Grazing services promoted using both wild species and livestock to reduce fire risk.	Prescribed fires and domestic livestock grazing remain a part of certain traditional and cultural production systems.
Freshwater Ecosystems	Restore as many freshwater ecosystems as possible,	Restore freshwater ecosystems that provide NCP.	Restore freshwater ecosystems with cultural/traditional

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Topic	NfN	NfS	NaC
	maximising ecological integrity.		value or areas linked to emblematic species.
	Dams are removed when they are barriers for species and ecological flows.	Dams are removed unless they provide NCP (e.g., flood regulation, sediment retention, water quality and control of invasive species).	Dams are removed unless they create landscapes of cultural value (e.g., freshwater systems important for culture).
Agriculture	Large-scale farming integrated with NBS to protect ecological integrity and resilience.	Large-scale farming and NBS to provide NCP.	Small-scale farming to support traditional agricultural and agropastoralism practices with high conservation and cultural values.
	Precision farming.	Precision farming.	Organic farming.
	Land sparing.	Land sparing/sharing.	Land sharing.
Urban systems	Continuation of population flow from rural areas to cities.	Urban sprawl in peri-urban areas to increase access of population to green areas and NCPs.	Population flow from cities to rural areas.
	High-rise compact cities but no sprawl.	Moderately compact cities.	No high-rise compact cities and no sprawl. Increased population in rural areas.
	Rewilding of city parks and return of wildlife to cities.	Expansion of green infrastructure in cities.	Expansion of urban gardens.
Energy	Renewable Energy Sources (RES) in or nearby built-up, degraded areas to avoid areas important for connectivity or endangered and sensitive species.	RES in or close to urban areas (to facilitate access to energy) or in agricultural landscapes to reduce land-take impacts on biodiversity.	RES in isolated areas to reflect society's preference for living far from RES, and to avoid culturally important places and landscapes.

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Topic	NfN	NfS	NaC
	None to minimal plantation (fast-growing trees) for biofuel.	Biofuel plantation (fast-growing trees) is relevant.	None to minimal trees for biofuel.

2.2.1. Nature for Nature

In the **NfN perspective, nature's intrinsic value is central to humans**. Nature has a high value on its own, independent of the benefits to people. Natural areas under strict protection are set to drastically reduce human intervention in ecosystem processes. By reducing the sprawl of new infrastructures and the demand for biofuel, whose production requires large areas, there is more space for wilderness. Protection of nature primarily aims to achieve the undisturbed functioning of self-regulated ecosystems, instead of seeking to manage nature for material and non-material benefits that people may get. Ideas such as non-management, rewilding (the ecological process of letting nature take its course through reducing long-term management), the improvement of resilience to disturbances and the restriction of extractive uses, are key to this scenario wherever possible (Figure 13).

Figure 13: A possible representation of the Nature for Nature narrative. © NaturaConnect

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Protected Areas in Nature for Nature

The selection of PAs to achieve 30% coverage emphasises their capacity to retain ecological integrity and resilience to environmental changes. PA expansion focuses on preventing the extinctions of species, reducing extinction risk, increasing ecosystem integrity and allowing natural processes to take place. Natural and semi-natural areas, and areas with high biodiversity value and evolutionary potential (e.g., the ability to track niches in climate change as we expect many species to lose suitable habitats) are protected and connected. Species protection is based on the need to maintain and restore functionally complex ecological communities and complete phylogenies. Preserving keystone species (i.e., species that maintain the integrity of the ecosystems) is important for the maintenance of ecosystem functions.

Strict protection is carried in areas of Natura 2000 sites and other PAs with high ecological integrity, with an emphasis on large area. These may also be selected to include the most irreplaceable and representative sites (i.e., samples of the existing ecosystems and species in the territory overall). They should be identified through the best available data and methods with the support of the scientific community. The focus is on areas where habitats and species are most sensitive to human disturbance and where active conservation management is most needed, as well as on areas suitable for rewilding, i.e., allowing natural processes to dominate. This would include for example primary and old-growth forests, last wilderness areas and breeding sites of selected species more sensitive to disturbance.

PAs are located in areas where human activities can be minimized, to reduce the impacts on nature. The vision primarily aims to establish large, protected areas that can sustain self-regulated ecosystems, but smaller protected areas also can play a complementary role (e.g., targeting endemic and other species with narrow distribution ranges). These smaller areas can be part of corridors and stepping stones between larger areas, as presented in the next section, especially in highly fragmented landscapes.

Conservation measures are implemented within and around PAs, extending Natura 2000, the pre-existing European PA network and other PAs. Human activities within PAs are regulated in line with conservation objectives and may be allowed only when they are compatible with maintaining and gradually restoring protected species, habitats and ecosystem integrity. Minimal infrastructure development (e.g., forest roads) is allowed inside PAs to this end. However, important roadless areas are preserved and no new infrastructure is allowed in strictly protected areas. Removal of infrastucture such as dams and roads in strict protected areas have high priority. The 10% of PAs under strict protection are characterised by no

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extractive uses and no human intervention and a long-term goal to restore wilderness. Inside and outside PAs, monitoring programs ensure that negative species or habitat trends get detected early, and effective protection measures get identified and applied promptly.

Connectivity and Restoration in Nature for Nature

A key priority in NfN is the protection and restoration of ecological connectivity to help recover ecological flows characteristic of undisturbed ecosystems. Large-scale corridors are integrated in a coherent nature protection network, to support the dispersal and migration of organisms and gene flow. Corridors contribute to preventing species extinctions, support natural recolonisation processes, strengthen the robustness of meta-communities and help recover abundant wildlife and species populations in general.

Large-scale restoration programs are favoured to achieve the establishment of self-sustaining ecosystems e.g., on lands undergoing abandonment and in semi-natural and natural areas where rewilding is feasible. Where possible, restoration approaches take advantage of self-regulating ecosystem processes (e.g., natural ecological succession, wildlife comeback, etc). In addition, restoration actions are implemented to help species redistribute to suitable habitats under climate change.

Green and Blue Infrastructure is planned in areas where it supports the establishment of functional ecological corridors (e.g., stepping stones, green belts, etc.). Obsolete and redundant infrastructures (such as river barriers, roads, etc.) are removed, especially in areas where they reduce barriers to native species movements.

Forests in Nature for Nature

Resource extraction (e.g., forest harvest, hunting) is reduced to the extent possible in all protected forests, and in primary and old-growth forests, passive restoration approaches that promote natural ecological processes are implemented to enhance the structural, functional and compositional complexity of forests. To offset the loss of areas for production, other forested areas with low biodiversity value are exploited and new native forests are planted, according to a land sparing approach. Transition from exotic tree plantations to native tree plantations and promotion of multi-aged and more diverse stands is promoted, but with forest production and resilience to climate change also being considered in forest management decisions. Fire-risk is reduced through natural grazing with increased diversity and density of wild ungulates, while prescribed fires may be re-established in areas where forest suppression policies have drastically reduced natural fire disturbances.

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Freshwater Ecosystems in Nature for Nature

Freshwater ecosystems are protected, and their connectivity is guaranteed, including features that encompass the whole network such as rivers, streams linked to floodplains (from local and regional levels), wetlands, groundwaters and aquifers. Free-flowing rivers are preserved and restored at large scale in those areas where they can contribute more to increase the ecosystem integrity. As dynamic systems, wetlands help biodiversity to adjust to climate warming, and are thus given particular emphasis to support shifts in species communities. Wetlands that cover larger areas are protected and restored through re-wetting and other restoration efforts. In addition, this future is characterised by the restoration and conversion of small post-agricultural abandoned areas, not currently protected, to wetlands. Dams and other water infrastructures can be developed in non-conservation areas, e.g., to sustain the production of renewable energy, but always taking the relevant measures to avoid and minimize impacts on biodiversity, which in practice strongly limits the deployment of any new hydroelectric dams.

Agriculture in Nature for Nature

Overall, a land sparing approach is preferred, which means that high-intensity systems are maintained to leave more space for nature conservation. Large-scale farming is envisioned except for areas within and next to PAs. The extent of highly intensive agricultural areas slightly decreases but de-intensification is not feasible everywhere, thus these areas remain intense to ensure current and future food demand and to avoid impacts on high biodiverse areas of conservation priority. In this context, NBS (e.g., integrated pest management, regenerative farming) mitigate the effects of pesticide use and chemical inputs and provide minimum natural elements in the landscapes such as woodland islets and hedgerows, stone walls, etc., while maintaining high yields as much as possible. Medium-intensity systems expand and converge with high-intensity systems, while low-intensity systems decrease and those lands get converted to PAs or are rewilded. Precision farming is encouraged to optimise both agricultural input and output and to reduce extra water consumption during irrigation.

Urban system in Nature for Nature

High-rise compact cities are developed to leave space for nature, and no increase in urban sprawl is expected. In a continuation of trends of the last decades, people move from rural villages mostly to large cities, and to a smaller extent, regional towns, and this shift reduces impacts on nature. Meanwhile, nature recolonises abandoned villages and peri-urban areas. Green spaces are managed to protect ecological processes and promote urban rewilding. A range of approaches are used to improve connectivity to promote wildlife and plant dispersal. Connectivity within cities is improved with green roofs for pollinators and bird species and

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linear natural elements along bike paths and rivers. Conservation gardening to protect endangered species in rooftops and other urban habitats expands. Connectivity between urban and rural areas is increased by ensuring continuity of natural habitats between urban parks and important natural habitats beyond the limits of the city. Reducing light pollution is a top priority to protect migratory species and to improve the naturalness of urban areas.

Energy in Nature for Nature

Sustainable energy production plants (wind and solar farms) are avoided as much as possible in areas of high ecological integrity, in PAs and buffer areas around these, and in areas important for preserving and restoring ecological connectivity. Energy plants are allocated in degraded areas and high-intensity agricultural landscapes. Power lines are built along already existing infrastructures and can be hidden underground, if possible, to avoid species disturbance. None to minimal plantation (fast-growing trees) is allocated to biofuel.

2.2.2. Nature for Society

In the **NfS value perspective**, the **utilitarian benefits** and **instrumental values provided by nature** are highlighted, thus **ecosystems are managed to prioritise and enhance the provision of NCP**. Natural areas are integrated with a matrix of human land use to facilitate access of people to NCP, and multifunctional and multiscale landscapes are sustainably managed. Society pursues sustainable development, adopting win-win solutions for nature and for people in different sectors (Figure 14).

Figure 14: A possible representation of the Nature for Society narrative. © NaturaConnect

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Protected Areas in Nature for Society

The PA network is managed to maximise NBS, to guarantee the NCP provisioning in as many places as possible, particularly regulating and non-material NCP, such as, pollination, carbon sequestration, micro-climate regulation, fire risk regulation, soil creation/soil erosion prevention and recreation. The protection of species and habitats is prioritised when they provide specific services. Examples include insect pollinators or medicinal plant species.

PAs are located in areas where the demand for NCP is high. The network encompasses both small and large PAs since size depends on the services they provide. Large PAs are selected for water and flood regulation and carbon sequestration. Smaller PAs are established in proximity to people and supply pollinator habitats around crops, air quality regulation and pest control. Strict protection is focused on preserving the most critical NCP.

There is a moderate to high tolerance towards human activities within PAs (e.g., hunting, extensive farming). Grazing would occur as it facilitates sustainably low-intensity used landscapes with anthropogenic and natural features. Forestry for wood production is also allowed by setting level thresholds for harvesting, to meet the demand sustainably. Roads, railways and wind parks are allowed in PAs; overall, the impact from infrastructure is minimised through the application of compensation mechanisms to offset the impacts on nature. In this scenario, even in strictly PAs, some activities can be allowed such as grazing, hunting and logging when contributing to management goals.

Connectivity and Restoration in Nature for Society

The connectivity of landscapes and ecosystems aims to support the provision of multiple NCP (e.g., pollination, fishing, improved water quality, carbon storage, etc.). Green and Blue Infrastructure is developed especially in peri-urban areas to provide services closer to people . Urban and peri-urban parks, tree rows in agricultural areas, restored woodland islets, more natural forests and other natural solutions help to increase climate change adaptation and mitigation measures, while also benefiting biodiversity. Green and Blue Infrastructure also connects rural landscapes and farmlands with high natural value (e.g., some pastures or low-intensity cultivated lands) with open woodlands, water bodies and peri-urban and urban areas. The design and restoration of ecological corridors are planned according to their capacity to provide multiple NCP. The ecological integrity of ecological corridors is less relevant, but they must contain natural elements that provide identifiable regulating, non-material and/or material services. Active restoration measures are implemented to reverse soil erosion, enhance water quality and reduce ecosystem degradation overall, and as a means of preventing risks associated with natural hazards such as flood events, wildfires, etc. with NBS.

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Forests in Nature for Society

Sustainable forest management is carried out to support multi-functional forests that meet multiple needs, for example, timber production, extraction and economic value; flood regulation; pest control; carbon sequestration; recreation; and biodiversity value, among others. In contrast with the NfN scenario, active afforestation is envisioned, but it makes use of native species. Forests are restored around cities and in highly degraded areas of low nature value to maximise benefits and/or access to people. Forest management may consist of very long-term rotations of forest practices that allow multifunctionality at each place over time. Grazing and browsing by large herbivores are used to reduce fire risks using both wild species and livestock.

Freshwater Ecosystems in Nature for Society

Freshwater systems are restored to improve NCP provisioning (e.g., water quality, water supply, river flow regulation, wild fish supply). Multifunctional areas that can provide different services simultaneously are preferred. Restoring cost-effective wetlands, especially small-scale wetlands near landscapes threatened by intense land use, is favoured. Restoration of freshwater ecosystems (e.g., rivers, wetlands, peatlands) allows key processes to take place, like recharging of aquifers by rewetting lands and prevention of flood risks, erosion and eutrophication. Carbon sequestration, movement of nutrients and cooling of cities are also improved. Riparian systems are managed to provide flood regulation, reduction of erosion risk, climate change mitigation and water quality improvement. Obsolete dams in rivers are removed and the impact of other dams on biodiversity is prevented without affecting energy provision and other services.

Agriculture in Nature for Society

In agricultural landscapes in particular, co-benefits with NCP are a priority. Agricultural production is expected to take place in highly productive areas not of conservation concern, while also concentrating resources on existing multi-functional landscapes, and giving priority to regulating services. Even if large-scale farming is overall predominant in this scenario, highly intense agricultural systems slightly decrease compared to current agricultural landscapes and integrate with elements of NBS to reduce chemical inputs. Low-intensity and medium-intensity systems, on the other hand, moderately increase in coverage. In the latter, natural features such as hedgerows are improved to attract pollinators and pest regulators. Precision farming, which makes farming more efficient, reduces impacts on the environment. Overall, a mixed approach between land sparing and land sharing is envisioned.

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Urban system in Nature for Society

Configuration of urban areas aims at improving contact between society and natural features, to facilitate NCP provisioning. Therefore some urban sprawl being is expected in peri-urban areas. Urban green elements and NBS, such as permeable parking, sustainable drainage systems, green rooftops and cold air flows (cooling processes that reduce the urban heat island effect), ensure sustainability of urban environments by supporting human well-being, climate resilience and climate change adaptation in cities. These NBS also distribute regulating services among people at the local scale, such as pollination, shade, flood and erosion prevention, water infiltration/retention and carbon sequestration.

Energy in Nature for Society

Renewable solar and wind energy plants are placed within agricultural landscapes to reduce the overall footprint of food and energy production. Priority is given to the overall impacts on biodiversity, rather than the effects on single species. The location of energy-producing plants in the wider landscape is carefully planned to minimise potential impacts, while still guaranteeing NCP. In this scenario, visible power lines are allowed if their presence does not affect biodiversity. Tree plantations for biofuel production (using fast-growing species such as poplars) are incentivised too.

2.2.3 Nature as Culture

The **NaC value perspective** focuses on **relational values between nature and people's culture (e.g., sense of place, participation, stewardship, spirituality, reciprocity)**, strengthening the **personal connection that humans have with nature**. Emphasis is given to traditional land use practices and experiences that connect people to specific landscapes (e.g., Farm to Fork initiatives, wine routes, transhumance of livestock, biodiversity-friendly farming, pilgrimage routes, hiking and enjoyment of nature); consequently, the belief systems and behaviours adapt to a society where nature centred education and lifestyles are a priority. The connection that people feel towards the environment is strengthened by an increase in community-based management initiatives. Emphasis is given to the heterogeneity of cultural landscapes across Europe. Overall, the land sharing principle prevails more than in the other perspectives, by integrating nature within human-managed systems (Figure 15).

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Figure 15: A possible representation of the Nature as Culture narrative. © NaturaConnect

Protected Areas in Nature as Culture

An expansion of the PA network not only aims to meet conservation objectives but also preserves cultural services and protects cultural/heritage landscapes with high natural value. Conservation of culturally relevant species is prioritised. Some migratory birds and fish considered symbolic and charismatic species, and those that hold recreational value (e.g., for birdwatching) are protected. Small PAs aims to protect pocket parks inside cities or preserve large old trees and culturally important bird species that require habitat outside urban areas. Early successional habitats such as semi-natural grasslands and hay meadows, and other important habitats of European countryside landscapes are prioritised for protection, often through networks of micro-reserves. Agro-forestry systems with high biodiversity such as Dehesa in Spain and wood pastures in central Europe are also protected.

Strict protection is applied in areas that include species and habitats associated with cultural landscapes or of high cultural value (e.g., the Hoopoe as a bird of myth). Old trees in cities, coastal areas, small sensitive areas that include breeding habitats for iconic species, and traditional and indigenous landscapes, such as those managed by the Sami people in northern Scandinavia, are strictly protected.

PAs are preferentially located near the human population to enable people's access to nature. There are large PAs to protect specific cultural landscapes for tourism purposes and to support local livelihoods (e.g., locally expanded villages in Croatia that rely on stork breeding sites).

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There is a high tolerance in PAs for human activities, such as low-intensity traditional farming and forestry, hunting and other extractive cultural activities (e.g., mushroom and truffle harvesting, wild berry and wild honey harvesting etc.), particularly because many of the protected habitats and species are dependent on such practices. Infrastructure development is permitted to create access for people. Wind parks and infrastructure are not allowed within PAs when the landscape has culturally important visual appeal. Traditional and community activities may be allowed even in strictly PAs.

Connectivity and Restoration in Nature as Culture

Overall, connectivity is improved through Green and Blue Infrastructure, to connect and actively restore the habitat of culturally important species and bring nature back in highly degraded areas. The generation of Green and Blue Infrastructure allows people to reconnect with nature, especially when these areas are located between urban and rural areas. To connect with people's positive emotions and culture, landscapes with cultural, educational and/or historical importance are restored (e.g., agroecological landscapes). Connectivity restoration brings back green areas and healthy rivers and wetlands to rural areas and cities for people's enjoyment. Famous or notable natural areas and landscape landmarks such as UNESCO World Heritage Sites (e.g., Ancient and Primeval Beech Forests of the Carpathians and Other Regions of Europe Carpathians forests) are a focus for conservation and restoration.

Forests in Nature as Culture

In forestry, a land sharing approach where local communities manage forests prevails, even if from a minimum intervention perspective. Native forests are recognised as assets, particularly for local communities (e.g., Sami people). Active afforestation and forestry practices that favour tree species of high cultural value are preferred. There is an expansion of agroforestry landscapes (e.g., wood pastures and dehesa/montado type landscapes). Pre-existing highly modified environments around cities are allocated to wood production forests since this provides the opportunity to promote green belts for recreational purposes. Within forests, fires are prescribed to support traditional and cultural production systems.

Freshwater Ecosystems in Nature as Culture

Freshwater ecosystems with a historical and cultural role or those that are important for emblematic species are protected and restored. This is particularly relevant in areas that are important for improving connectivity, allowing low-intensity human activities and enhancing local economies. Restoration of wetlands linked to traditional and recreational use is carried out. Riparian forest systems are restored, planting culturally relevant tree species to provide

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recreational activities, access to livelihoods and cooling cities. The removal of dams is achieved, although leaving aside those that are located in heritage sites or contribute to the cultural landscape.

Agriculture in Nature as Culture

Priority is given to the revitalisation of extensive and traditional agricultural practices in rural areas with high conservation and cultural values (e.g., vineyard cultivations in Italy, orchards in Spain). The connection between similar landscapes to maintain cultural identity is fundamental to ensure agropastoralism practices, such as transhumance (i.e., seasonal movements of livestock towards more suitable areas for grazing). Contrary to the NfN scenario, in NaC large-scale farming gets converted to small-scale farming to promote cultural heritage, and highly intense systems decrease and converge with low ones that allow for sustainable use of resources. Also, medium-intensity systems converge with increased low-intensity areas (e.g., organic, permaculture and regenerative farming). Cultivated lands are located near settlements to have a shorter supply chain and a land sharing approach is likely, which means that agricultural lands incorporate natural elements rather than keep them separate. Indeed, more emphasis is given to extensive grazing, meadows, hedgerows, small forest patches and forest hedges, that can support current culturally important agrobiodiversity, and improve connectivity.

Urban system in Nature as Culture

No high-rise compact cities are envisioned. Spaces merge seamlessly with the surrounding landscapes due to the improvement of connectivity that brings natural and green elements, such as rivers and green bridges, into the cities. People need to reconnect with nature, which drives them to shift from large cities and peri-urban areas to medium and small settlements in rural areas, favouring the re-flourishing of rustic villages and small regional towns. Green urban areas become useful for protecting endangered and culturally relevant species and for urban embellishment by placing plant species with different flower timing along the streets. Urban gardening expands, to provide urban dwellers opportunities to interact with nature in a culturally meaningful way,

Energy in Nature as Culture

The placement of infrastructure and plants for energy production is informed by the cultural relevance of the landscapes and traditional management strategies: large-scale renewable energy plants are placed in isolated areas to reflect society's preference for living far away from them and avoiding culturally important places. Meanwhile, smaller installations (e.g., wind and solar panels) for the use of local communities are built, because of more sustainable

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lifestyle choices. Power lines are built underground to preserve the aesthetic values of landscapes. None to minimal trees are planted for biofuel production, which is promoted instead through energy crop species useful for preserving culturally important values.

3. Translation of narratives into scenario settings and indicators

3.1. Settings for land use

3.1.1. Introduction to spatial land use modelling

The NaturaConnect project will make use of the spatial land use model CLUMondo, to simulate plausible scenarios of land use change outcomes based on the NFF storylines for Europe. CLUMondo (Asselen and Verburg, 2013; Schulze et al., 2021) is a spatially explicit land use allocation model that simulates land use changes over large areas using process representation and empirically quantified relationships between land use and its driving factors or demands. In addition, the competition between different land use types is also modelled dynamically. Spatial policies and restrictions, land use type-specific conversion settings, land use demands, and location suitability are all considered in the allocation procedure and comprise some of the key model inputs. Spatial policies and restrictions indicate areas where land use changes are restricted through policies or tenure status, for example, strictly protected areas would be restricted from changing land use. Land use specific conversions determine the temporal dynamics of simulations based on the reversibility of land use change, and other rules for conversion of one land use type to another. Land use demands include trajectories of demands for wood, fuel, livestock and food made by a dynamic population. Finally, location suitability represents the outcome of how suitable an area of land is to meet a specific demand.

By considering all these factors in the spatial allocation procedure, CLUMondo can simulate plausible scenarios of land use outcomes based on each of the NFF storylines. These scenarios will help design a robust TEN-N by:

1. Providing the context of land use changes in which the TEN-N is to be designed;
2. Assessing the changes in land use as a result of potentially implementing the TEN-N, including the potential displacement of impacts; and

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3. Helping the design of additional measures of biodiversity protection such as enhanced connectivity and priority areas for enhancing green infrastructure in terms of increasing the extent and improving the quality in existing areas.

The effects of different sustainability targets like expanding protected areas, no-net-loss and restoration of natural areas, reduction in nitrogen emissions, or tree planting may be implemented in CLUMondo by adding additional demands for goods and services provided by land systems, and also by regulating the land system conversions that may take place (i.e., both the type and location of land conversions). Thus, we can simulate different trajectories for the NFF scenarios by setting different targets for conservation and sustainability measures, and by adjusting the way these are implemented to determine how land use is impacted in terms of the distribution and area of land needed to meet specific demands. For example, to model the phasing out of farming on previously drained wetland soils, the conversion rules for land systems can be changed so that such farms are allowed to convert back to peatlands after a fixed number of years, which represent the time taken for the wetlands to be restored. This can be combined with specific targets on percentages of areas that must be restored to give an idea of where these restoration actions are most likely to occur. Similarly, different perspectives on how sustainable land management practices can be operationalised can also be represented by adjusting input for the spatial allocation procedure.

One challenge in modelling the NFF scenarios is that CLUMondo itself does not model changes to macro-economic demands. So, these values must be derived from existing economic scenarios (e.g., from integrated assessment models such as GLOBIOM for the SSPs) providing regional forecasts for population and production of goods and services (e.g., crop, livestock, or wood). Macro-economic demands that cannot be modelled by CLUMondo include total agricultural production to be achieved (resulting from a global consumption/production trade balance dealt with by GLOBIOM models) and total wood demand (which could be derived from GLOBIOM-G4M outputs).

NaturaConnect will use existing scenario simulations with global scale economic models to depict the broader macro-economic changes that occur due to radical changes in sustainable consumption or increased technological efficiency. Therefore, these are externally determined and may not exactly reflect changes in these conditions stated by stakeholders during the workshops. Thus, for the purpose of NaturaConnect, CLUMondo will instead align macroeconomic demands with the existing GLOBIOM model outputs for the SSPs. Specifically, the macro-economic context and demands projected in SSP1 and RCP2.6 will be used, as these align best with the positive future envisioned in all the NFF scenarios in

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terms of a high commitment to sustainable development, and strong climate change mitigation measures.

However, the goal of the project is to design a TEN-N that is also resilient to more extreme climate and land use change scenarios. Thus, scenarios based on the macro-economic and climate context of SSP3 and RCP7 will also be considered to test the sensitivities and robustness of the outcomes and resilience of TEN-N configurations. RCP7 is a baseline outcome that represents the medium-high range of future emissions if no additional climate policy is implemented (van Vuuren et al., 2011), and SSP3 reflects a trajectory of development with regional rivalry, material intensive consumption and slower economic growth (Riahi et al., 2017). All the scenarios that will be considered are represented in the cells of the matrix of Table 3:

Table 3: Suggested NFF-SSP matrix within which to define model specifications.

European NFF/Global contextual scenarios	**RCP2.6**	**RCP7**
SSP1 + NFF1: Nature for Nature	Positive and optimistic outlook, with nature's intrinsic value having priority.	Combination not possible.
SSP1 + NFF2: Nature for Society	Positive and optimistic outlook, with nature's contributions to people having priority.	Combination not possible.
SSP1 + NFF3: Nature as Culture	Positive and optimistic outlook, with nature's cultural value having priority.	Combination not possible.
SSP3 (standard elaboration for Europe)	Combination not possible.	Robustness check: Stressed land use and stressed climate effects in context of TEN-N.

3.1.2. Using CLUMondo to map land use outcomes of the NFF

For CLUMondo, the focus is to understand how different targets or priorities would affect potential land use change in terms of distribution and area per land use system. Thus, the overall storylines for each NF will be translated into scenarios for CLUMondo by identifying various priorities, targets or strategies described in the storylines that have the potential to affect land use outcomes. These are then implemented in CLUMondo as 'demands' that must be met by the spatial allocation algorithm, or as 'conversion rules' that dictate which land systems can convert to other use types and over what time. Some of the conversion rules will

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also be established through feedbacks from other parts of the NaturaConnect analysis, which will provide initial characterisations of potential conventional and strictly protected areas to CLUMondo. Once the model has been run, maps with land use outcomes in each NF are generated. These outcomes would then indicate different opportunities and constraints for the development of the TEN-N under a specific NFF vision. An example of potential outcomes in each NF is shown in Figure 16:

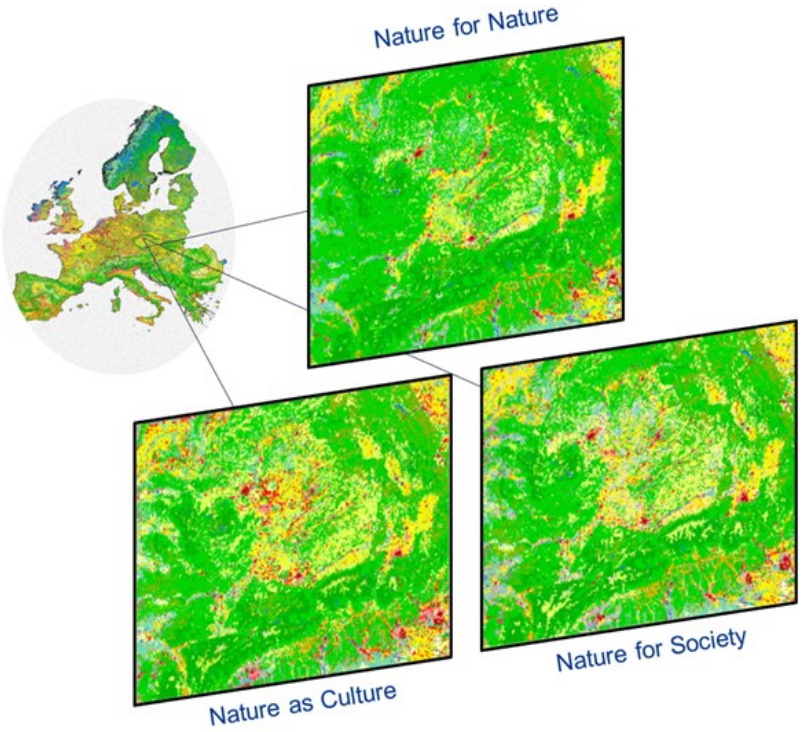

Figure 16: Land use outcomes for NF scenarios representing different prioritisation of valued social and environmental landscape features. Source: Dou et al., 2023.

3.1.3. Scenario settings for CLUMondo

Based on the storylines of each NFF perspective, Table 4 has been compiled to indicate how the scenarios will be implemented in CLUMondo. It is assumed that macroeconomic demands are set based on SSP1.

It should be noted that Table 4 is still a draft version, based on the outcomes of the stakeholder workshop and webinar, and will be further adjusted after considering policy targets and expert opinions. In addition to the model specifications mentioned in the table below, some additional specifications that better explore the broad themes discussed in the narratives will be added. These specifications would still be very much consistent with the existing narratives but would address model settings not elaborated in the storylines. For example, by exploring within each

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of the NFs how agricultural intensification trends are different in the North, South, East and West of Europe; how trees from the EU Biodiversity Strategy's commitment to plant 3 billion additional trees will be allotted across sectors; the differential placement of green elements; and the distribution and proximity of organic farms to urban areas or nature.

Table 4: Implementation of sustainability policy targets in the CLUMondo model according to the three NFF perspectives.

Policy Domain/Sector	Indicator/Model Specification	NfN	NfS	NaC
Agriculture	**Overall intensity trends while continuing to meet demand for food**	Extent of medium-intensity systems increase and converges with high- intensity systems in some cases.	Medium-intensity systems increase slightly.	Medium-intensity could converge with lower intensity systems to become IUCN category 6.
		Low-intensity decreases and some are converted to PAs.	Low-intensity increases slightly.	Alternatively (to above), lower intensity systems could increase and converge with medium-intensity systems.
		Land sparing is favoured so highly biodiverse areas can be protected.	Land sharing is encouraged, but not favoured	Land sharing is likely.
	Agrobiodiversity	Increase in meadows and conversions from abandoned land. New large, forested areas near agricultural lands.	Agrobiodiversity encouraged closer to settlements where it can enhance NCP.	Extensive grazing and meadows.
	Rural revitalisation to make these areas stronger, more connected, resilient and prosperous	Neutral to low importance.	Medium importance for revitalisation.	Very high importance for revitalisation.
		Rewilding abandoned landscapes is given high importance.	Rewilding abandoned landscapes is given low importance.	Rewilding abandoned landscapes is given very low importance.

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Policy Domain/Sector	Indicator/Model Specification	NfN	NfS	NaC
	Conserving agricultural systems of cultural value	Medium importance given, so some conversions may be allowed. There will be no modernisation or scale enlargement of such systems.	Medium to low importance on conserving agricultural systems of cultural value.	High importance is given to conserving existing agricultural systems of cultural value.
	Organic farming and Nature-based Solutions (NBS)	NBS are integrated with large- scale farming.	NBS are encouraged to reduce pesticide use and chemical input.	Organic farming near settlements.
	Precision farming	Increased precision farming.	Increased precision farming.	No priority for precision farming.
Forestry	**Management type**	Old-growth forests are prioritised and conserved.	Temporal rotation of forests (80-100 years) to achieve multifunctionality over time with new plantations in less pristine areas or abandoned areas.	Minimal changes to culturally valued forests (e.g., North Finland) with land sharing.
		Protection of primary forests and plantation of new forests in less pristine areas that prioritise native species.		
		Restore disturbed natural forests.	Land sharing is promoted, leading to more multifunctional areas with lower intensities of use.	Land sharing approach, leading to more multifunctional areas with lower intensities of use.
		Land sparing approach, resulting in stricter separation between different uses of land, and areas dedicated to high intensity use.		

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Policy Domain/Sector	Indicator/Model Specification	NfN	NfS	NaC
	Location of productive forests (oriented to wood production)	In areas with low biodiversity potential. Some forests with no harvesting.	In areas with maximum productivity and where co-benefits with regulatory NCP are high.	Around urban areas, promoting green belts (but less in Mediterranean areas because of fire-risk).
	Forest fire-risk	Wild ungulates to graze and reduce fire-risk.	Livestock and wild ungulates to graze and reduce fire-risk and trees in peri-urban areas are carefully planned.	Prescribed fires and promote traditional/cultural agroforestry systems.
	Forest location	In regions promoting ecological connectivity.	In regions promoting supply of NCP.	In regions that can help restore cultural and historical significance.
Grasslands	**Grazing**	Wildlife grazing promoted only in protected grassland.	Grazing by livestock to reduce fire-risk.	Agropastoralism is promoted and preserved.
Wetlands	**Wetlands restoration**	Wetlands restoration is important.	Allot trees to prevent floods, erosion etc.	Restoration of culturally important wetlands.
Biofuel	**Plantation for biofuel**	None to minimal plantation for biofuel. Most biofuel comes from waste or agricultural residue.	Biofuel plantation encouraged. 30% of trees allotted for biofuel.	None to minimal trees for biofuel.
Urban areas	**Urban green**	Connect cities with green corridors.	Increased urban green elements and urban agriculture.	Green areas that re-introduce culturally important species and urban gardening.
	City expansion	No increase in urban sprawl of cities.	Moderately increased urban sprawl.	Increased rural areas.

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3.2. Settings for connectivity

Connectivity concerns the connections that allow for the dispersal of flora and fauna, water and nutrients across a landscape (Crooks and Sanjayan, 2006). Conservation and restoration of this ecological connectivity are extremely important for the survival of individual populations and the maintenance of ecosystem services such as water capture and delivery, carbon storage, as well as the preservation of landscapes that trigger important relational values and recreational opportunities. Modelling connectivity is primarily focused on identifying those corridors that most effectively connect key habitat areas and on identifying important corridors that are most vulnerable and in need of protection. These findings can then be implemented through the planning of new PAs or environmental restoration projects.

Connectivity modelling is most generally divided between structural and functional connectivity. Structural connectivity assesses how the physical configuration of the landscape (e.g., its elevation, slope, or land cover type) is structured and where that in turn will act as a resistance to the flow of organisms across the landscape. Without inputting specific data on dispersal movements and population dynamics, it focuses on identifying the areas in a landscape that are structurally connected and where individuals or populations are likely to move through over time. Functional connectivity differs from structural connectivity by explicitly accounting for the effects of species movements on population demography and/or genetics. The addition of this information on how species truly interact with their environment, and how different human activities correlate to movement patterns, provides more robust scientific inference on the placement of conservation corridors. Finally, connectivity planning can address multiple needs simultaneously. For example, the protection and restoration of important corridors for certain species can also achieve collateral benefits such as increasing carbon sequestration by the vegetation and soils, therefore preventing the degradation of regulatory ecosystem services.

Table 5: Settings for implementing ecological connectivity given different connectivity priorities according to the three NFF perspectives.

	NfN	**NfS**	**NaC**
Priorities for conserving and restoring structural connectivity	Conserve roadless areas.	Increase Green and Blue Infrastructure connecting peri-urban landscapes.	Landscape mosaics and hedgerows in agricultural, agroforestry and rural landscapes.

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	Reduce fragmentation by infrastructure in high integrity landscapes.	Green and blue corridors across cultivated land.	Greening in cities, including gardens and green roofs.
	Rewilding of marginal areas.	Dam removal and increased lateral connectivity in rivers to mitigate floods.	Transhumance routes.
Priorities for conserving and restoring functional connectivity	Species targets: all species with a focus on trophic complexity and highly threatened species; maintain species genetic diversity.	Species targets: promote species that provide specific services; increase species richness overall.	Species targets: charismatic and symbolic species; game species (hunting, fishing).
	Planning corridors: conservation and restoration of corridors between high-integrity forests, shrublands and wetlands, including large-distance dispersal and migration corridors.	Planning corridors: multifunctional corridors for beneficial species and maximising other NCP.	Planning corridors: road verges and verges in other linear infrastructures for plants/corridors for charismatic species and hunting species.
	Dam removal targeting the restoration of functional communities in rivers.	Implement 'buzz lines' for pollinators.	Wetland connectivity of fish recreational species.
Priorities for connecting PAs	Small PAs are embedded in large-distance corridors designed to connect large PAs.	Short- and medium-distance connections between (typically small) PAs embedded in high-intensity landscapes.	Connect high-nature value protected farmlands.
			Preserve green belts.

3.3. Settings for Systematic Conservation Planning (SCP)

Systematic Conservation Planning (SCP) is a common approach to identifying priority areas which would best contribute to the protection of species or habitats at a regional or global level, including the conservation of multiple species (Margules and Pressey, 2000; Nicholson et al., 2019) or NCP (Jung et al., 2021; O'Connor et al., 2021). SCP is a structured approach

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to locating and designing PA networks that achieve set objectives. One main objective of SCP is to maximise the spatial representation of multiple features (e.g., species, ecosystems, or NCP), within a set of priority areas that are complementary and irreplaceable for the set of features considered (Kukkala and Moilanen, 2013).

The NaturaConnect project will use the NFF land use change scenarios as one of the inputs for identifying priority areas using multi-criteria spatial planning algorithms, to identify the best locations for PA expansion. The priorities identified will complement the existing European PA network in terms of species, habitats and NCP, while also accounting for future changes in climate or land (including the NFF scenarios described above) as well as socio-economic considerations.

It is important to note that the three corners of the NFF triangle are extreme cases, whereas the mix of perspectives on nature conservation that influence local or national decisions on land use will always be somewhere in the middle of the triangle. For these reasons, the SCP analyses will include some intermediate assumptions between the three perspectives and explore small variations around them.

From a conservation planning perspective, the NFF narratives can be integrated in several ways, including through:

- *Identifying opportunities and constraints for conservation and restoration.* Land use change scenarios which translate the NFF influence the opportunities and constraints in terms of places that can be protected or restored.
- *Identifying suitable habitats within the future distributions of species and ecosystems.* Land use change scenarios that translate the NFF affect the suitability of habitats for species which are prioritised, as well as the capacity and demand for NCP.
- *Accounting for alternative preferences of different values of nature (Table 6).* Alternative scenarios of PA expansion can be produced that reflect the relative preference in different values of nature, using feature-specific weights in the prioritisation. For instance, in the NfN pathway, one would assign higher weight (preference) to the intrinsic value of species and ecosystems; in the NfS pathway, a higher weight would be assigned to the instrumental benefits of species and ecosystems for human society and wellbeing (e.g., carbon sequestration, pollination of croplands, disease control).
- *Accounting for conservation priorities in NFF scenarios*. Top priorities for conservation identified would then be used to develop a second iteration of NFF land use change

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scenarios to avoid the loss of key areas for conservation, and to further strengthen benefits for nature in these scenarios.

In the NaturaConnect project, coordination and feedback between work areas on nature futures scenarios and systematic conservation planning for PAs is taking place, and is evaluating not only how biodiversity-informed protection priorities can feed into future land use change, but also the displacement (leakage) effects of conserving certain areas of land over others, which can have implications elsewhere as production demands for crops, timber and energy have to be met.

Table 6: Accounting for alternative values of nature through the lens of the NFF to identify priority areas for the expansion of the European PA network.

	NfN	NfS	NaC
Priorities for the 30% conventional PAs	The intrinsic value of nature has high priority here. Both nationally rare and EU-wide key areas for species and habitats are important. Prioritise areas that are resilient to climate change or would be needed for the resilience of species across the network.	Ecosystems that provide regulating NCP have high priority here. Some should be prioritised to satisfy local demand (e.g., flood regulation by catchment level, pollination for crops). For others, the demand is global, e.g., carbon sequestration.	Ecosystems of cultural value have high priority here, including high nature value farmland. Similar to NfS, certain culturally valuable species or ecosystems should be prioritised to meet local demand (e.g., recreation, wild foods). Tourism and heritage landscapes can be prioritised EU-wide.
Priorities for the 10% strictly PAs (within the 30%)	The overarching objective in this narrative is to prevent extinctions. Sensitive species, threatened species, all remaining old-growth forests should be strictly protected.	Ecosystems with societal benefits where the function or service depends on non-intervention: old-growth forests, carbon rich ecosystems (e.g., peat bogs) as carbon storage is sensitive to disturbance.	Culturally valued species and ecosystems, where the capacity to provide the benefit depends on non-intervention (e.g.: patches of culturally valuable landscapes within broader cultural landscapes; breeding sites for iconic species; old- growth trees).

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4. Next steps

The narratives presented here describe possible nature futures for Europe, guided by stakeholder visions and preferences, aligned with European policy objectives and targets, and based on the IPBES Nature Futures Framework. Although each narrative is distinct in its value of nature (intrinsic; instrumental; relational), there are several commonalities across the storylines, which share the same background in terms of economic development, demography and lifestyles and policies. This set of narratives can reflect socio-cultural contexts, local systems and cultural values and a more sustainable use of natural resources, by placing the human-nature relationship at the core.

This is the first public deliverable produced by NaturaConnect, a project that will run until mid-2026. The narratives presented here lay the foundations for the development of the project in the coming years. At the same time, these narratives are not deemed to be a static product. Going forwards, the narratives will be enriched with further details, and may be expanded to cover topics that were not accounted for previously. The associated settings will be further refined and used in the project to enhance the development of land use scenarios simulations, relate to nature conservation scenarios, explore pathways for connectivity and further expand the conservation priorities. The set of indicators of progress towards the three Nature Future corners (Nature for Nature, Nature for Society, Nature as Culture) will be extended. We produced these narratives with the intent to provide an open access tool that can be used and developed by others beyond NaturaConnect. Therefore, it is our hope that they will be useful to other projects as a basis to develop their own project-specific settings and indicators, to enrich the landscape of Nature Futures scenarios for Europe while ensuring comparability and interoperability of the outputs.

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NATURA CONNECT

5. References

Abbott, J., Davies, P., Simkins, P., Morgan, C., Levin, D., & Robinson, P. (2013). Creating water sensitive places–scoping the potential for water sensitive urban design in the UK. *CIRIA, London*.

Baisero, D., Schuster, R., & Plumptre, A. J. (2022) Redefining and mapping global irreplaceability. *Conservation Biology*; 36: e13806. https://doi.org/10.1111/cobi.13806

Brown, J. (2010). The World Café: Shaping our future through conversations that matter. ReadHowYouWant. Com.

Brown, N. (2004). SILVICULTURE | Natural Regeneration of Tropical Rain Forests. Editor(s): Jeffery Burley, Encyclopedia of Forest Sciences, Elsevier. Pages 1062-1066, https://doi.org/10.1016/B0-12-145160-7/00232-5.

CAN Europe (2020). EEB technical summary of key elements. Building a Paris Agreement Compatible (PAC) energy scenario.

Casson, S.A., Martin V.G., Watson, A., Stringer, A., Kormos, C.F. (eds.). Locke, H., Ghosh, S., Carver, S., McDonald, T., Sloan, S.S., Merculieff, I., Hendee, J., Dawson, C., Moore, S., Newsome, D., McCool, S., Semler, R., Martin, S., Dvorak, R., Armatas, C., Swain, R., Barr, B., Krause, D., Whittington-Evans, N., Gilbert, T., Hamilton, L., Holtrop, J., Tricker, J., Landres, P., Mejicano, Gilbert, T., Mackey, B., Aykroyd, T., Zimmerman, B., Thomas, J. (2016). Wilderness Protected Areas: Management guidelines for IUCN Category 1b protected areas. Gland, Switzerland: IUCN. x + 92pp.

Chapman, R. L. (2006). Ecological restoration restored. *Environmental Values*, *15*(4), 463-478. 10.3197/096327106779116096.

Dahlin, J.ll, Svensson, E. (2021). Revitalizing Traditional Agricultural Practices: Conscious Efforts to Create a More Satisfying Culture. Sustainability 13, 11424. https:// doi.org/10.3390/su132011424.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., ... & Zlatanova, D. (2015). The IPBES Conceptual Framework— connecting nature and people. Current Opinion in Environmental Sustainability, Vol. 14, Pag. 1-16. https://doi.org/10.1016/j.cosust.2014.11.002.

Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., ... & Shirayama, Y. (2018). Assessing nature's contributions to people. *Science* 359, 70-272.DOI:10.1126/science.aap8826

Dou, Y., Zagaria, C., O'Connor, L., Thuiller, W., Verburg, P. H. (2023). Using the Nature Futures Framework as a lens for developing plural land use scenarios for Europe for 2050. Submitted for review.

Dudley, N., and Sue Stolton, S. (eds) (2008). Defining protected areas: an International conference in Almeria, Spain. Gland, Switzerland: IUCN. 220 pp

Elliott, J., Gah, E., Hartley, K. and Vis, C. (2017). Discussion Paper: Ecological Representation. Pathway to Canada Target 1.

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NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

Ellis, E. C., Pascual, U., and Mertz, O. (2019). Ecosystem services and nature's contribution to people: negotiating diverse values and trade-offs in land systems. Current Opinion in Environmental Sustainability, vol. 38, pag. 86-94.

EC, Directorate-General for Environment, Mézard, N., Sundseth, K., Wegefelt, S. (2008). *Natura 2000: protecting Europe's biodiversity*, Wegefelt, S.(editor), Mézard, N.(translator), European Commission. https://data.europa.eu/doi/10.2779/45963

EC (2019). Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Review of progress on implementation of the EU Green Infrastructure strategy. European Commission. COM 236. Brussels.

EC (2020 a). Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. The Farm to Fork Strategy for a fair, healthy and environmentally-Friendly food system. European Commission. COM 381. Brussels.

EC (2020 b). EU biodiversity strategy for 2030: bringing nature back into our lives. Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions. European Commission. COM 380. Brussels. https://data.europa.eu/doi/10.2779/048.

EC (2022 a). European Commission. COMMISSION STAFF WORKING DOCUMENT. Criteria and guidance for protected areas designations. Brussels.

EC (2022 b). Proposal for a Regulation of the European Parliament and of the Council on Nature Restoration. Brussels, 22.6. 2022, COM 304 Final 2022/0195 (COD).

EC (2023). European Climate Law. European Commission. https://climate.ec.europa.eu/eu-action/european-green-deal/european-climate-law_en accessed on July 25.

EEA (2020). Building a coherent Trans-European Nature Network, 05/2020, European Environment Agency.

EurActive special report, Michalopoulos, S. (2015). Special report Innovation - feeding the world. Reformed CAP aims to respond to global food security challenge, pages 1-2.

Fischer, J., Abson, D.J., Butsic, V., Chappell, M.J., Ekroos, J., Hanspach, J., Kuemmerle, T., Smith, H.G. and von Wehrden, H. (2014), Land Sparing Versus Land Sharing: Moving Forward. Conservation Letters, 7: 149-157. https://doi.org/10.1111/conl.12084.

Ghofrani, Z., Sposito, V., & Faggian, R. (2017). A comprehensive review of blue green infrastructure concepts. *International Journal of Environment and Sustainability*, *6*(1).

Green, R.E., Cornell, S.J., Scharlemann, J.P.W. & Balmford, A. (2005). Farming and the fate of wild nature. *Science*, 307, 550- 555.

Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

Hilty, J., Worboys, G. L., Keeley, A., Woodley, S., Lausche, B., Locke, H., ... & Tabor, G. M. (2020). Guidelines for conserving connectivity through ecological networks and corridors. *Best practice protected area Guidelines Series*, *30*, p-122.

Holl, K. D., & Aide, T. M. (2011). When and Where to Actively Restore Ecosystems? Forest Ecology and Management, 261, 1558-1563. https://doi.org/10.1016/j.foreco.2010.07.004.

IFOAM (2003). Training Manual for Organic Agriculture in the Tropics. Edited by Frank Eyhorn, Marlene Heeb, Gilles Weidmann, p 190-209, http://www.ifoam.bio/

International Symposium on Agroecology (2018). Agro-ecology trainings through permaculture. Permaculture for Agroecology in Urban Environments.

IPBES (2016). The methodological assessment report on scenarios and models of biodiversity and ecosystem services. [Ferrier, S., Ninan, K. N., Leadley, P., Alkemade, R., Acosta, L. A., Akçakaya, H. R., L., Brotons, W. W., Cheung, L., Christensen, V., Harhash, K. A., Kabubo-Mariara, J., Lundquist, C., Obersteiner, M., Pereira, H. M., Peterson, G., Pichs-Madruga, R., Ravindranath, N., Rondinini, C. and Wintle, B. A. (eds.)]. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 348 pages.

IPBES (2016 b). Guide on production and integration of assessments from and across all scales. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn.

IPBES (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Brondizio ES, Settele J, Díaz S, Ngo HT (eds) IPBES secretariat, Bonn, Germany, p 1148. https://doi.org/10.5281/zenodo.3831673.

IPBES (2019). Narrative Approaches. https://www.ipbes.net/narrative-approaches accessed on 4th August 2023.

IPCC (2022). Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Pörtner, H.-O., Roberts, D.C., Tignor, M., Poloczanska, E.S., Mintenbeck, K., Alegría, A., Craig, M., Langsdorf, S., Löschke, S., Möller, V., Okem A., Rama, B. (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.

IUCN (2008). Definition of “Protected Area”. https://www.iucn.org/our-work/topic/effective-protected-areas

IUCN (2016). A global standard for the identification of Key Biodiversity Areas: version 1.0. IUCN Global Species Programme, IUCN Species Survival Commission (SSC), IUCN World Commission on Protected Areas (WCPA)

IUCN CEM Rewilding Thematic Group, (2020). Rewilding Principles

Joint FAO/WHO Codex Alimentarius Commission, Joint FAO/WHO Food Standards Programme, & World Health Organization (2007). *Codex Alimentarius Commission: Procedural Manual*. Food & Agriculture Org.

Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

Kim, H., Peterson, G. D., Cheung, W. W. L., Ferrier, S., Alkemade, R., Arneth, A., Kuiper, J. J., Okayasu, S., Pereira, L., Acosta, L. A., Chaplin-Kramer, R., Den Belder, E., Eddy, T. D., Johnson, J. A., Karlsson-Vinkhuyzen, S., Kok, M. T. J., Leadley, P., Leclère, D., Lundquist, C. J., … Pereira, H. M. (2023). Towards a better future for biodiversity and people: Modelling Nature Futures. Global Environmental Change, 82, 102681. https://doi.org/10.1016/j.gloenvcha.2023.102681.

Kutama, A. S., Mani, A. M., and Aisha, W. A. (2012). Investigating the Nature of Seed-Borne Infection of Loose Smut Induced by Sporisorium cruentum (Kuhn)Potter in Partially Infected Sorghum Seeds in Northern Nigeria. Savannah Journal of Agriculture, Vol. 7(2).

Lundquist, C., Hashimoto, S., Denboba, M. A., Peterson, G., Pereira, L., & Armenteras, D. (2021). Operationalizing the Nature Futures Framework to catalyse the development of nature-future scenarios.

Mansur, A. V., McDonald, R. I., Güneralp, B., Kim, H., de Oliveira, J. A. P., Callaghan, C. T., ... & Pereira, H. M. (2022). Nature futures for the urban century: Integrating multiple values into urban management, Environmental Science & Policy, Vol. 131, Pag. 46-56. https://doi.org/10.1016/j.envsci.2022.01.013.

Millennium Ecosystem Assessment (2005). Ecosystems and human well-being: Synthesis. Washington, DC: Island Press.

Nature-Based Solutions Explained. www.connectingnature.eu (2020). https://connectingnature.eu/nature-based-solutions-explained

Nicholson, E., Watermeyer, K. E., Rowland, J. A., Sato, C. F., Stevenson, S. L., Andrade, A., ... & Watson, J. E. (2021). Scientific foundations for an ecosystem goal, milestones, and indicators for the post-2020 global biodiversity framework. *Nat Ecol Evol* 5, 1338–1349 (2021). https://doi.org/10.1038/s41559-021-01538-5.

Palacios-Abrantes, J., Badhe, R., Bamford, A., Cheung, W. W., Foden, W., Frazão Santos, C., ... & Pereira, L. M. (2022). Managing biodiversity in the Anthropocene: discussing the Nature Futures Framework as a tool for adaptive decision-making for nature under climate change. Sustain Sci. https://doi.org/10.1007/s11625-022-01200-4.

Pereira, L. M., Davies, K. K., den Belder, E. Ferrier, S., Karlsson-Vinkhuyzen, S., Kim, H., …& Lundquist, C. J. (2020). Developing multiscale and integrative nature–people scenarios using the Nature Futures Framework. *People Nat*. 2: 1172– 1195. https://doi.org/10.1002/pan3.10146.

Perino, A., Pereira, H. M., Navarro, L. M., Fernández, N., Bullock, J. M., Ceaușu, S.,... & Wheeler, H. C. (2019). Rewilding complex ecosystems. *Science*, *364*(6438), eaav5570.

Plaschke, M., Bhardwaj, M., König, H. J., Wenz, E., Dobiáš, K., & Ford, A. T. (2021). Green bridges in a re-colonizing landscape: Wolves (Canis lupus) in Brandenburg, Germany. *Conservation science and practice*, *3*(3), e364.

Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

Purnhagen, K. P., Clemens, S., Eriksson, D., Fresco, L. O., Tosun, J., Qaim, M., ... & Zilberman, D. (2021). Europe's farm to fork strategy and its commitment to biotechnology and organic farming: conflicting or complementary goals? *Trends in plant science*, *26*(6), 600-606.

Regenerative Agriculture. www.cbf.org (2023). https://www.cbf.org/issues/agriculture/regenerative-agriculture.html

Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O'neill, B. C., Fujimori, S., ... & Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, Global Environmental Change, Volume 42, Pages 153-168.

Rosa, I. M. D., Pereira, H. M., Ferrier, S., Alkemade, R., Acosta, L. A., Akcakaya, H. R., ... & Van Vuuren, D. (2017). Multiscale scenarios for Nature futures. *Nat Ecol Evol* 1, 1416–1419. https://doi.org/10.1038/s41559-017-0273-9.

Saito, O., Kamiyama, C., Hashimoto, S., Matsui, T., Shoyama, K., Kabaya, K., Uetake, T., Taki, H., Ishikawa, Y., Matsushita, K., Yamane, F., Hori, J., Ariga, T. & Takeuchi, K. (2019). Co-design of national scale future scenarios in Japan to predict and assess natural capital and ecosystem services. *Sustain Sci* 14, 5–21. https://doi.org/10.1007/s11625-018-0587-9.

Schulze, K., Malek, Ž. & Verburg, P. H. (2021). How will land degradation neutrality change future land system patterns? A scenario simulation study. Environmental Science & Policy, 124, 254-266. https://doi.org/10.1016/j.envsci.2021.06.024.

Someus, E. (2009). Recycling and upgrading of bone meal for environmentally friendly crop protection and nutrition: the PROTECTOR project, Editor(s): Keith Waldron, In Woodhead Publishing Series in Food Science, Technology and Nutrition, Handbook of Waste Management and Co-Product Recovery in Food Processing, Woodhead Publishing, Pages 553-582, https://doi.org/10.1533/9781845697051.4.553.

Svenning, J-C. (2020). Rewilding should be central to global restoration efforts, One Earth, Volume 3, Issue 6, Pages 657-660, https://doi.org/10.101/j.oneear.2020.11.014.

United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019: Highlights (ST/ESA/SER.A/423).

Van Asselen, S., Verburg, P. H. (2012). A Land System representation for global assessments and land-use modelling. Glob Chang Biol., 18(10): 3125-3148. doi: 10.1111/j.1365-2486.2012.02759.x. Epub 2012 Jul 10. PMID: 28741836.

Van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., ... & Rose, S. K. (2011). The representative concentration pathways: an overview. Climatic Change 109, 5. https://doi-org.vu-nl.idm.oclc.org/10.1007/s10584-011-0148-z.

Vaughn, K. J., Porensky, L. M., Wilkerson, M. L., Balachowski, J., Peffer, E., Rigino, C. & Young, T. P. (2010). Restoration Ecology. Nature Education Knowledge 3(10) :66.

Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

Warra A. A., Prasad M. N. V. (2020). Chapter 16 - African perspective of chemical usage in agriculture and horticulture—their impact on human health and environment, Editor(s): Majeti Narasimha Vara Prasad, Agrochemicals Detection, Treatment and Remediation, Butterworth-Heinemann. Pages 401-436. https://doi.org/10.1016/B978-0-08-103017-2.00016-7.

Wiek, A., & Iwaniec, D. (2014). Quality criteria for visions and visioning in sustainability science. *Sustainability Science*, 9(4), 497– 512. https://doi.org/10.1007/s11625-013-0208-6

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6. Annexes

Annex 1: Table with examples of indicators extrapolated from the narratives.

TOPIC	NfN	NfS	NaC
Agriculture	Biodiversity in agricultural landscapes	% of agricultural surface increased	% of agricultural surface devoted to traditional agricultural practices
	% of agricultural surface decreased	Agricultural yield per hectare	Distance of small-scale farms from cities
Urban system	Reduction of land-take	Number of NBS in cities to provide NCP.	Increase in quality of life in cities (life satisfaction index)
	Increase of urban biodiversity	Reduction of air pollution	Area dedicated to gardens, urban parks
		Area dedicated to cooling cities	
Species conservation and Protected Areas	% of species for which extinction risk is reduced (Red List Index)	% of protected species associated with NCP (e.g., pollinators)	% of culturally relevant protected species
	% of wilderness areas	% areas for NCP provisioning (% areas for the sustainable use of natural resources)	% of Natural Monuments

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	Mean species abundance		Increase in accessibility to PAs for ecotourism (distance from the main cities)
Freshwater ecosystems	Biodiversity of freshwater species	Increase in water quality and water provision	Number of cultural activities enhanced
	% of freshwater ecosystem lands restored	Increase in carbon sequestration in wetlands	Improvement of fish stock
	Wetland Extent Trend Index		
Connectivity and Green Infrastructures	Decrease in habitat fragmentation	Increase in green surface of urban areas for accessibility to NCP	
Restoration	% of abandoned land surface that has been restored	number of restored NCP	number of restored sites of community important
	% of new tree planted surface		
	Proportion of land degraded over total land area		
Energy	Reduction of land-take	Gain in energy supply	Distance of RES plants from cities
	Reduction of RES plants impact on Species (e.g., % reduction in collisions with windmills)		
Forestry	Reduction of forest harvesting		Number of forested areas managed by local communities

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	Trends in Primary Forest Extent	% surface allocated to wood production carbon sequestration/ flood risk prevention	% surface dedicated to sustainable logging practices
	Forest Landscape Integrity Index		

Annex 2: Mentimeter questions on Nature Futures narratives asked during the online webinar "Exploring Nature Futures Scenarios for a resilient Trans-European Nature Network (TEN-N)" on 4 July 2023.

1 *In a Nature for Nature scenario, what activities would you restrict in strictly protected areas?*

2 *In a Nature for Society scenario, what activities would you restrict in strictly protected areas?*

3 *In a Nature as Culture scenario, what activities would you restrict in strictly protected areas?*

4 *In a Nature for Nature scenario, what kinds of forestry activities would be allowed?*

5 *In a Nature for Society scenario, what kinds of forestry activities would be allowed?*

6 *In a Nature as Culture scenario, what kinds of forestry activities would be allowed?*

7 *In a Nature for Nature scenario, what types of agricultural land uses should be promoted?*

8 *In a Nature for Society scenario, what types of ecosystem services can be reinforced in agricultural landscapes?*

9 *In a Nature as Culture scenario, what cultural landscapes are important for nature conservation?*

10 *How important is the reduction of agricultural land in each scenario?*

11 *In which scenario(s) do you think high-density urban areas should be emphasized?*

12 *Which green elements should be integrated into which scenarios?*

13 *In a Nature for Nature scenario, in which areas and ecosystems should we implement large-scale rewilding?*

14 *In a Nature for Society scenario, where could ecological corridors be prioritised?*

15 *In a Nature as Culture scenario, what measures can contribute to improve Green Infrastructure?*

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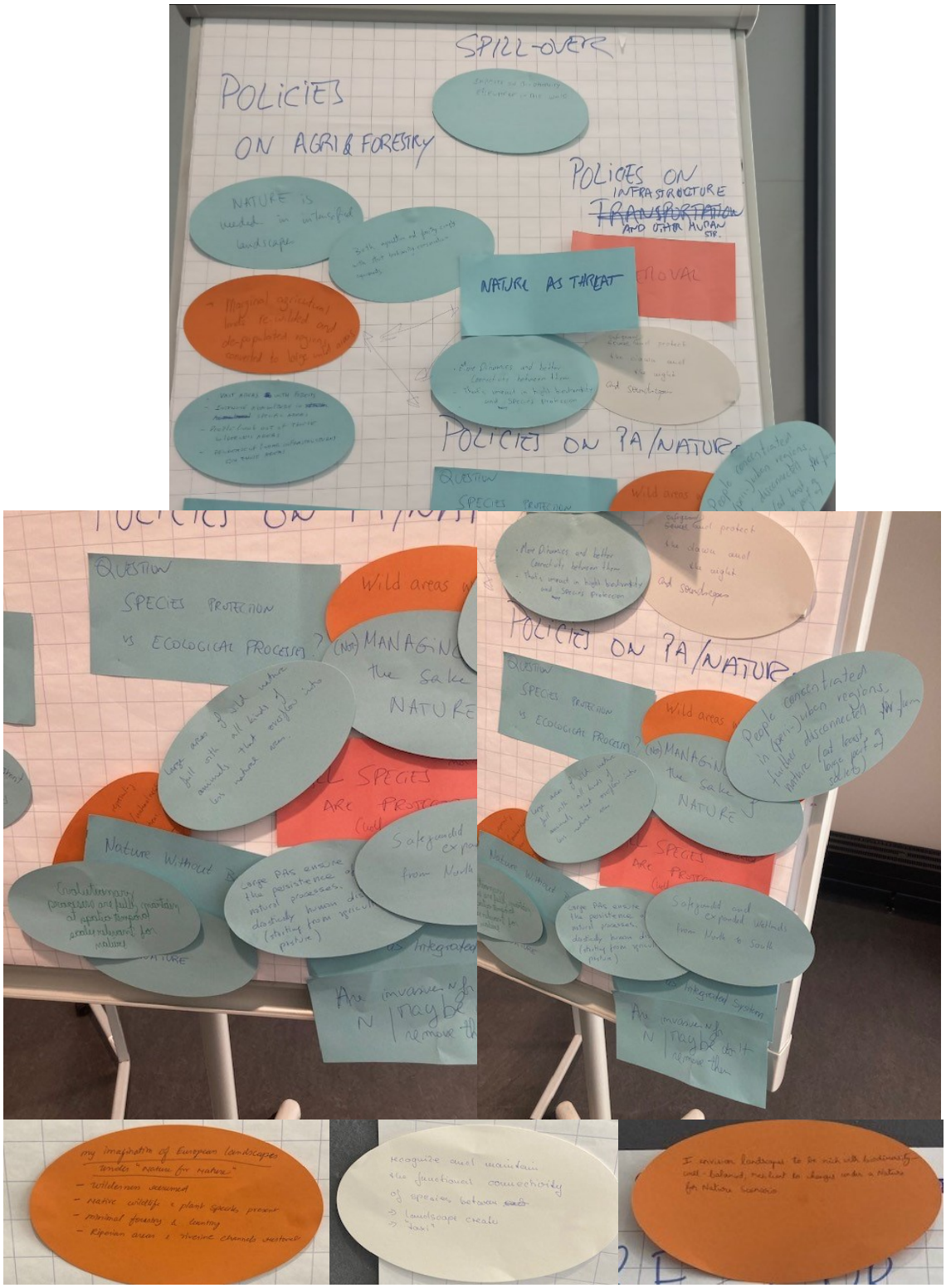
Annex 3: Workshop pictures of Nature for Nature session. Pictures of post-it notes from the Nature for Nature session, during day 1 of the workshop.



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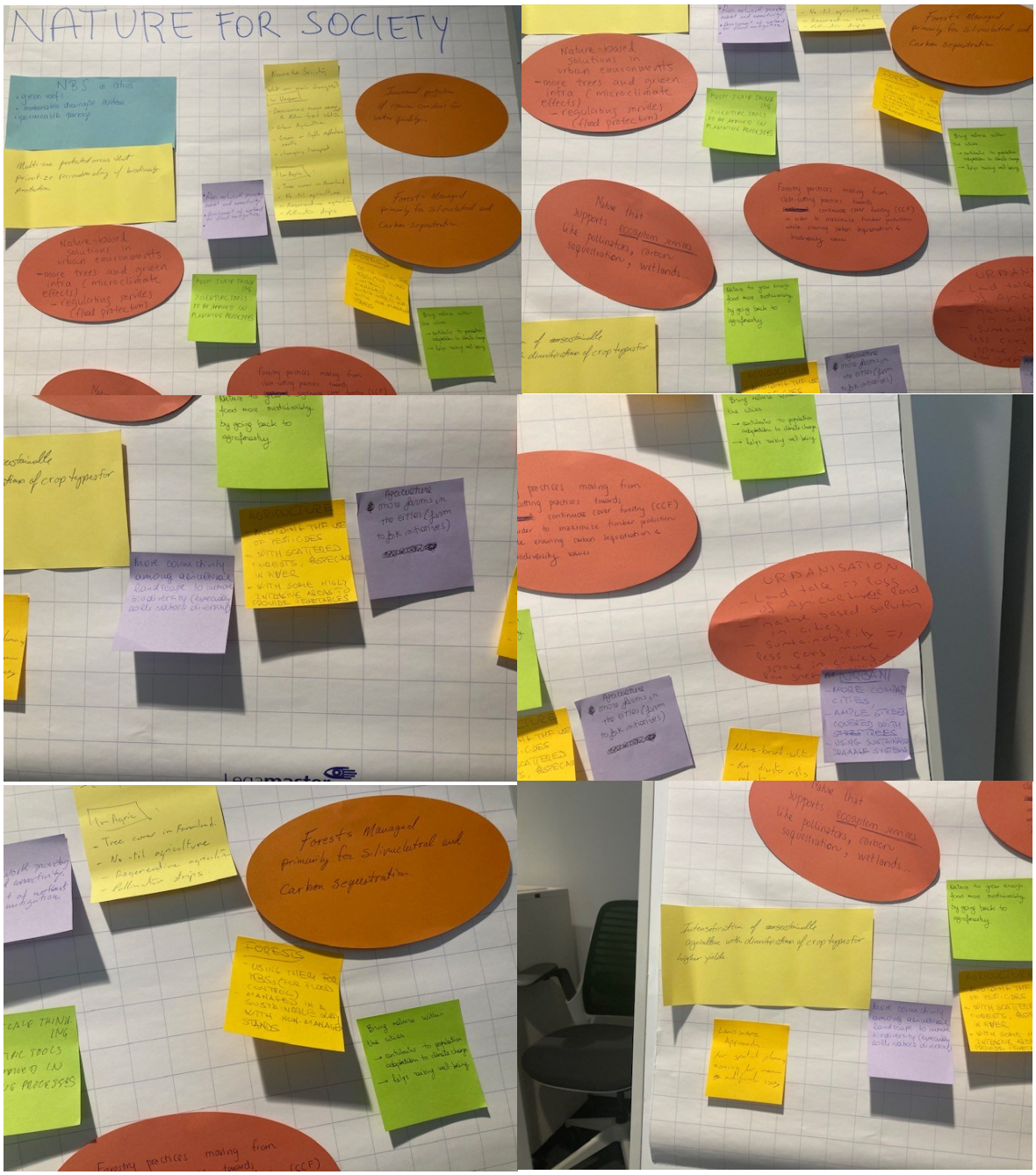
Annex 4: Workshop pictures of Nature for Society session. Pictures of post-it notes from the Nature for Society session, during day 1 of the workshop.



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Annex 5: Workshop pictures of Nature as Culture session. Pictures of post-it notes from the Nature as Culture session, during day 1 of the workshop.

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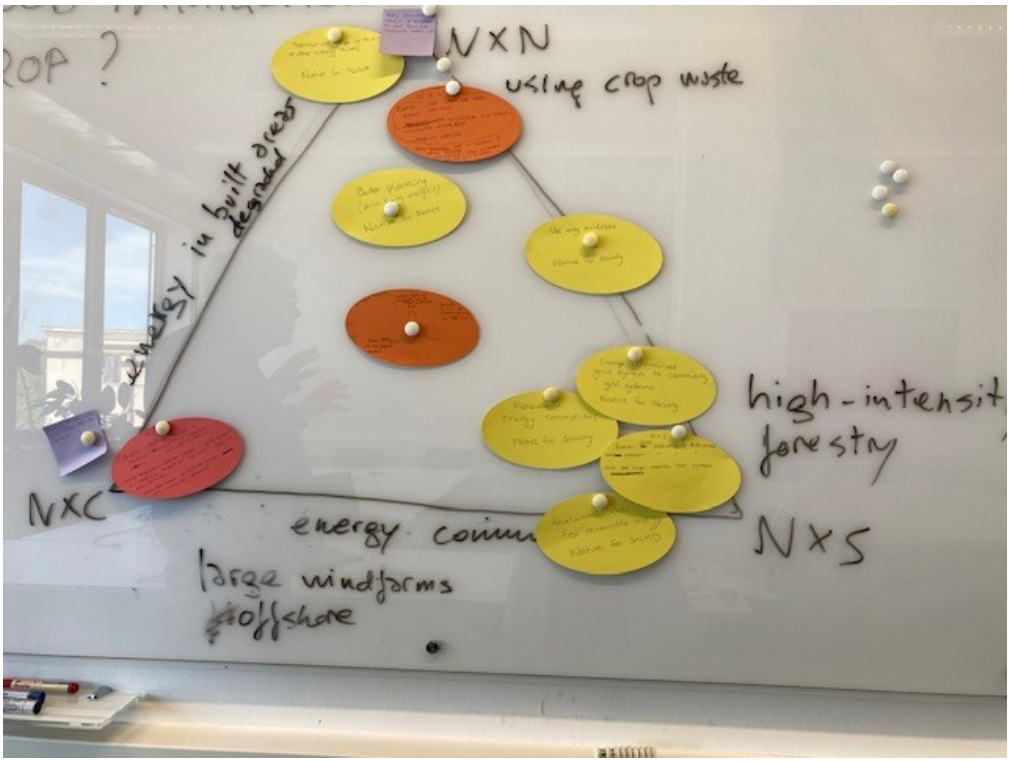
Annex 6: Workshop pictures of Energy session. Pictures of post-it notes from the Energy session, during day 1 of the workshop.



Annex 7: Workshop pictures of Species Conservation session. Pictures of post-it notes from the Species Conservation session, during day 2 of the workshop.

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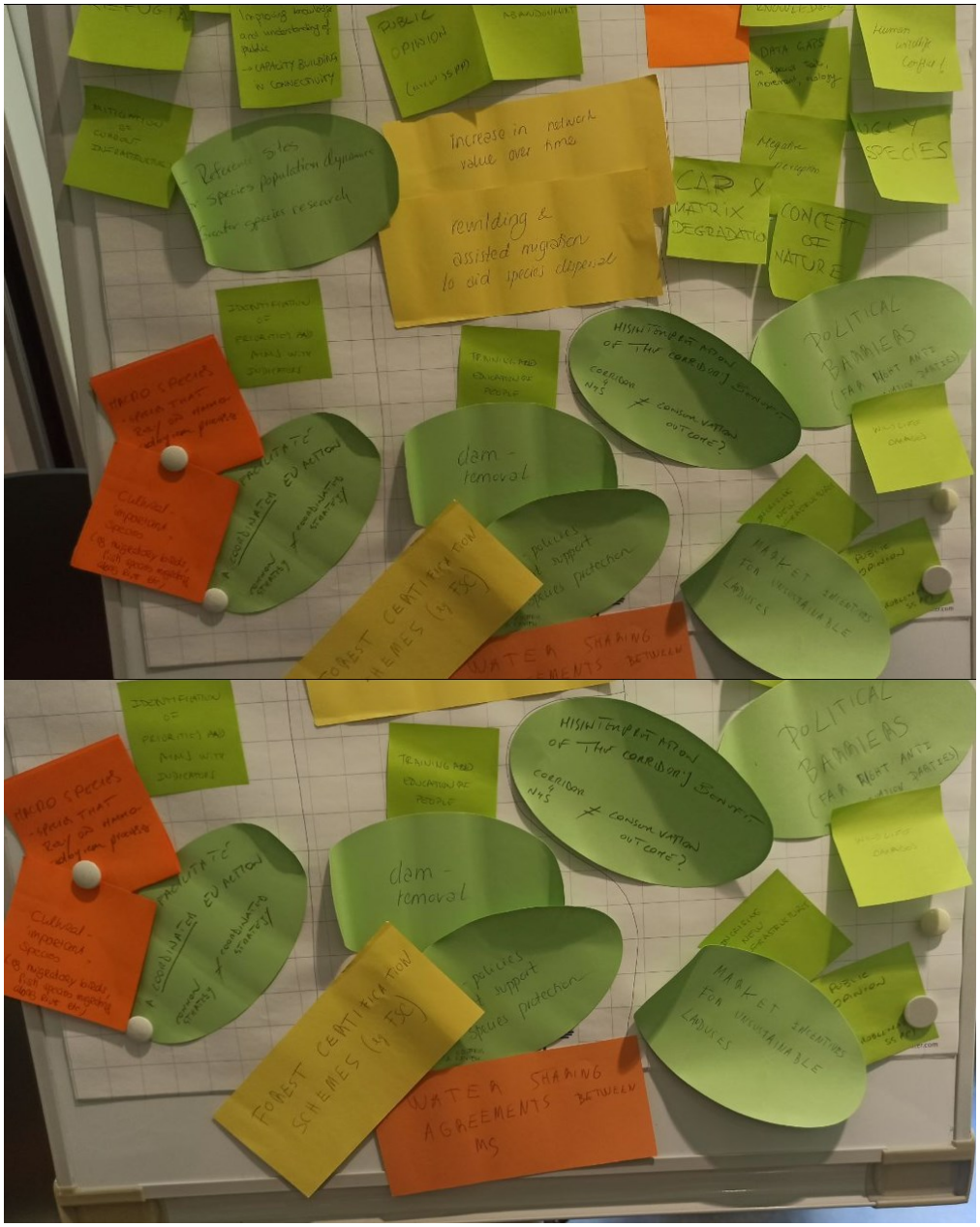

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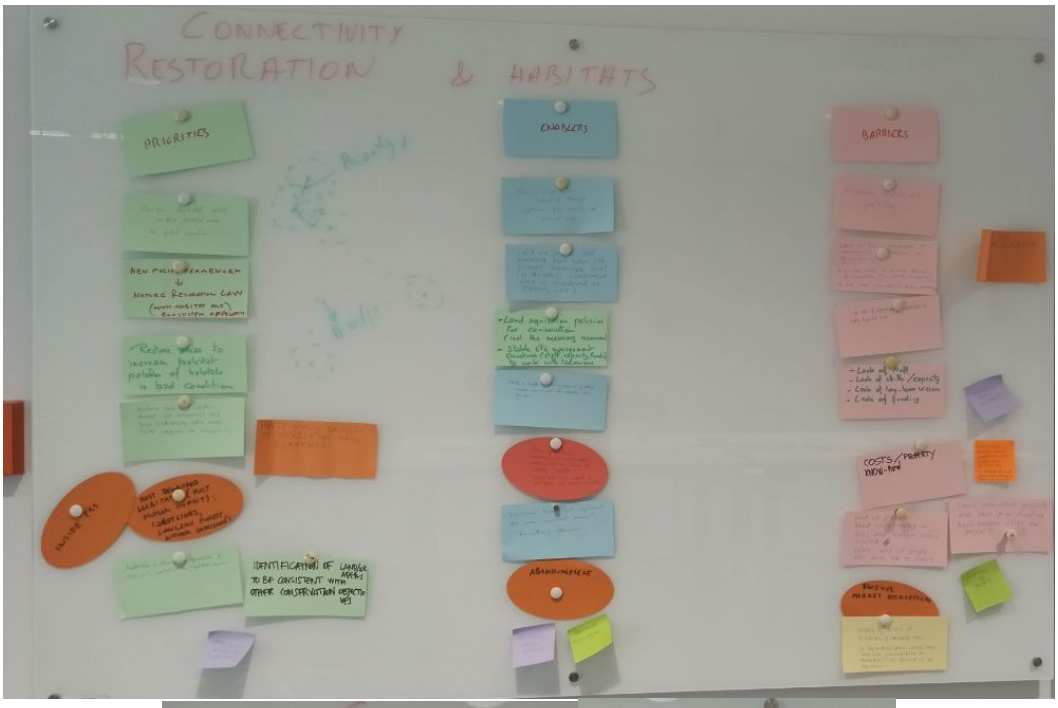
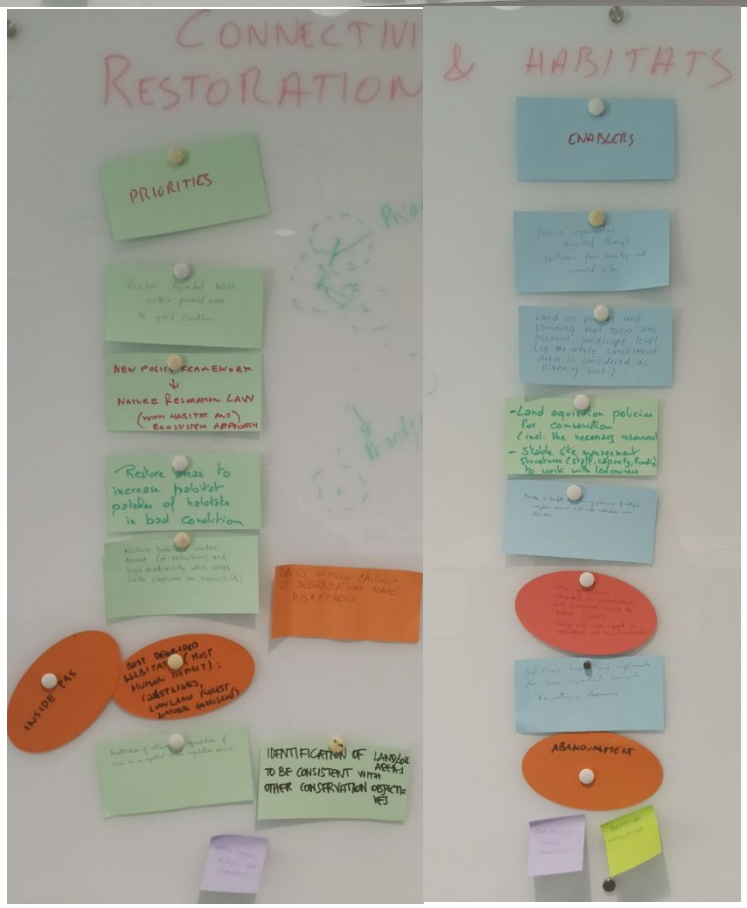
Annex 8: Workshop pictures of Restoration session. Pictures of post-it notes from the Restoration session, during day 2 of the workshop.





Funded by the European Union

NaturaConnect receives funding under the European Union's Horizon Europe research and innovation programme under grant agreement number 101060429.

NATURA CONNECT

More information about the project:

NaturaConnect has 22 partner institutions: International Institute for Applied System Analysis (project lead; Austria); German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig (project co-lead; Germany); Associacao Biopolis (Portugal); BirdLife Europe (Netherlands); Birdlife International (United Kingdom); Centre National De La Recherche Scientifique (France); Doñana Research Station - Agencia Estatal Consejo Superior De Ivestigaciones Cientificas (Spain); Europarc Federation (Germany); Finnish Environment Institute (Finland); Humboldt-University of Berlin (Germany); Institute for European Environmental Policy (Belgium); Netherlands Environmental Assessment Agency (Netherlands); Rewilding Europe (Netherlands); University of Evora (Portugal); University of Helsinki (Finland); University of Natural Resources and Life Sciences, Vienna (Austria); University of Rome La Sapienza (Italy); University of Warsaw (Poland); Vrie University of Amsterdam (Netherlands); WWF Central and Eastern Europe (Austria); WWF Romania and WWF Hungary.

NaturaConnect aims to design and develop a blueprint for a truly coherent **Trans-European Nature Network** (TEN-N) of conserved areas that protect at least 30% of land in the European Union, with at least one third of it under strict protection. Our project unites universities and research institutes, government bodies and non-governmental organizations, working together with key stakeholders to create targeted knowledge and tools, and build the capacity needed to support European Union Member States in realizing an ecologically representative, resilient, and well-connected network of conserved areas across Europe.

www.naturaconnect.eu

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