# Screening for restoration opportunities

## A spatial layer to screen for opportunities to deliver multiple benefits through ecosystem restoration in Europe

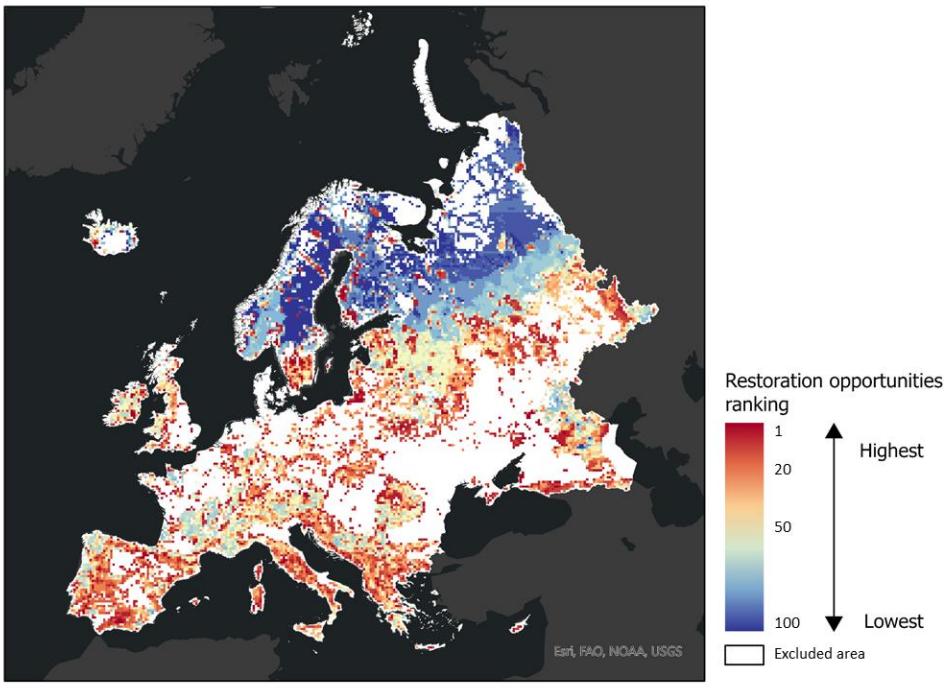


Figure 1: Restoration opportunities layer for Europe. (March 2023). The layer indicates the ranking of restoration opportunity of land in Europe from highest (red) to lowest (blue).

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Key Messages:

- The business case for restoration is growing, and there is increasing evidence that the cost of inaction is significantly higher than the cost of investing in nature.
- Spatial planning, including consideration of biodiversity benefits and Nature's Contributions to People, can aid private sector decision making on where to restore, prioritising investments that are as effective and efficient as possible.
- UNEP-WCMC has developed a spatial data layer to allow companies to screen for locations that offer opportunities to deliver multiple benefits through ecosystem restoration across Europe.
- This restoration opportunities screening layer indicates that the highest restoration opportunities across Europe are in the following areas: areas in Mediterranean countries, areas identified as Key Biodiversity Areas and Ramsar sites that currently show a degree of human impact, and areas upstream of population centres that hold potential to reduce gaps in current delivery of Nature's Contributions to People, among others.
- The restoration opportunities layer is intended to be used alongside other data as part of screening and scoping exercises and should be validated on-ground as appropriate.
- In the future, similar layers will be developed for different geographic regions so that a global picture emerges covering multiple ecosystems and benefits.

# Introduction

Ecosystem restoration* offers a widely recognised opportunity for the private sector to contribute towards positive outcomes for nature[1]. The private sector undertakes restoration both as a mandatory requirement to address impacts and as a voluntary and strategic action towards corporate sustainability commitments. The important roles of companies and financial institutions in the implementation of the UN Decade on Ecosystem Restoration and restoration related targets in the Kunming-Montreal Global Biodiversity Framework are widely recognised.

Location is one of the key determinants of the likelihood of success and efficiency in achieving restoration objectives. Spatial planning, when informed by biodiversity benefits and Nature's Contributions to People, is a useful tool to aid private sector decision-making around investing in the conservation and restoration of nature and ensuring that investments are as effective as possible while considering and balancing various trade-offs.

**UNEP-WCMC has developed a restoration opportunities layer to allow companies to screen for opportunities to deliver multiple benefits through ecosystem restoration across Europe.**

The layer aims to support early-stage identification and prioritisation of ecosystem restoration opportunities across Europe. The continent of Europe was selected due to good data availability coupled with the high restoration potential of the region. Similar layers will be developed for different geographic regions in the coming years so that a global picture emerges covering multiple ecosystems and benefits. The restoration opportunities layer is intended to be used alongside other data as part of screening and scoping exercises and should be validated on-ground as appropriate. Furthermore, considering socio-economic data such as data collected by national statistics that are disaggregated by sex and population groups will help to better inform decision-making and targeted action on the ground since diverse groups of women and men are impacted differently from the loss of biodiversity, climate change and pollution.

This technical brief outlines the methodology underpinning the restoration opportunities layer for Europe and explains how it can be interpreted and used by Proteus Partners. It also highlights some of its limitations and outlines the next steps for further development of the restoration opportunities screening layers.

# About the layer

## Methodology behind the restoration opportunities layer

The restoration priority was ranked across the area in Europe using a spatial optimisation approach to find the areas that maximise the potential co-benefit of restoration to nature and people. We used the Prioritizr package in R programming[2], a tool from the Systematic Conservation Planning framework[3] to perform the optimisation and rank opportunities hierarchically.

Spatial data on the potential of sites across Europe to contribute towards restoration targets for biodiversity and Nature's Contributions to People were included in the optimisation framework. Under this setup, areas that enhance multiple benefits are emphasised. The following

*This technical brief uses the terms 'ecosystem restoration' and 'restoration' inter-changeably

potential biodiversity benefits were considered in the ranking (Figure 2):

- recovery of areas with high potential rarity-weighted species richness[4],
- recovery of areas in ecoregions with higher restoration need[5],
- restoration of salt marsh areas under human pressure[6]
- restoration of areas under anthropogenic pressure within Ramsar[7] and Key Biodiversity Areas[8].

In terms of Nature's Contributions to People, the layer considers the following benefits:

- potential to maximise the amount of carbon sequestered in vegetation biomass[9]
- potential to restore populations of wild plant species that are used by the diverse groups of men and women that live in the continent as a genetic resource, food, medicine, source of material, and other traditional uses[10]
- areas with potential to maximise the reduction of deficits in the provision of Nature's Contributions to People locally, for the pollination, water quality regulation and coastal protection services[11].

The spatial optimisation methods implemented use restoration targets for the different spatial layers. These were calibrated at the continental level for biodiversity layers to ensure that the areas that represent better opportunities to enhance biodiversity in the continent are highlighted. In the case of Nature's Contributions to People, targets were calibrated at the country level. By considering country-level Nature's Contributions to People, we ensure that restoration opportunities are distributed across all countries and provide equitable access to restoration support from the private sector.

Areas that are under production activities (i.e., currently being used as croplands, pasturelands and other related land uses) and urban lands were not considered in the restoration opportunities layer. Furthermore, only areas under intermediate human pressure were included – the assumption being that areas under low human pressure would not require restoration, and areas under high human pressure are likely to include sites that would not be practical to restore (e.g., cities, industrial areas and other human infrastructure). The methodology underpinning the layer is explained in more detail in Annex 1.

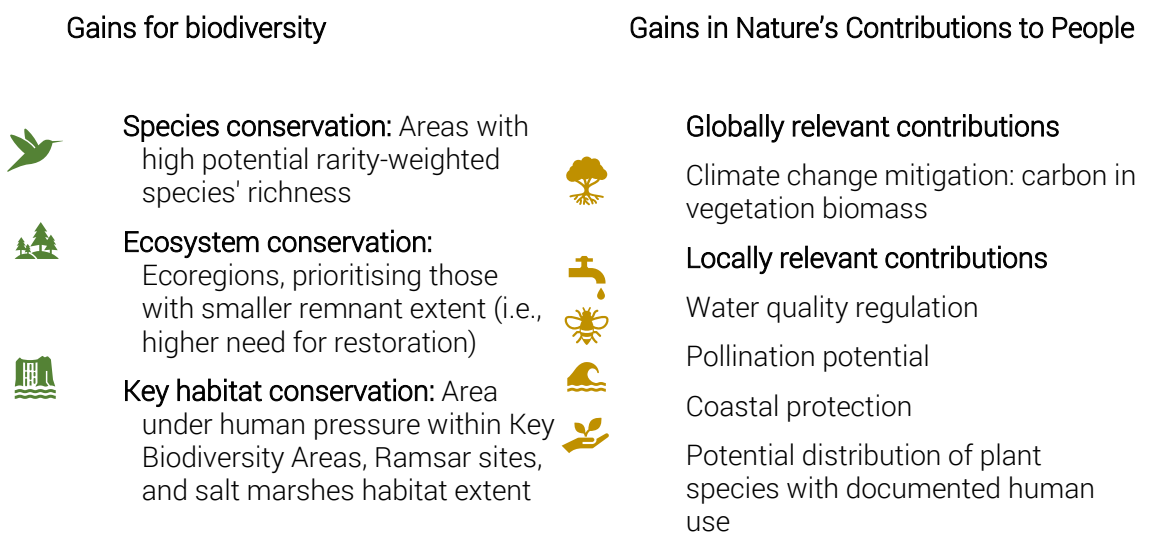


**Figure 2:** Potential benefits for biodiversity and Nature's Contributions to People that were considered in the restoration opportunities layer for Europe.

## How to interpret the layer?

The restoration opportunities layer can be used to identify areas in Europe where implementing restoration activities has potential to deliver the highest return on investment in terms of contribution towards biodiversity targets in the continent and the supply of Nature's Contributions to different groups of people.

Areas representing higher restoration opportunities are defined as those with potential to deliver a higher total benefit for biodiversity and people. The benefit of restoring each site results from its potential contribution towards targets for biodiversity assets of conservation relevance, combined with its potential impact enhancing the delivery of Nature's Contributions to People. In this sense, high opportunity sites are likely to combine providing benefits towards multiple assets and doing so in large amounts, while low opportunity sites would indicate areas where only a few assets would benefit from restoration and in more constrained amounts (Figure 3).

The resulting layer indicates that the highest restoration opportunities across Europe are represented by parts of the Mediterranean region, areas identified as Key Biodiversity Areas and Ramsar sites that currently show a degree of human impact, or areas upstream of population centres that hold potential to reduce gaps in the current delivery of Nature's Contributions to People locally.

Importantly, the areas that are indicated in the spatial layer as a lower priority should not be understood as areas where restoration would have a negligible impact. Since restoration opportunities are identified considering continental or national level data, areas that are naturally more diverse or where there is a larger population in need of increased Nature's Contributions to People might score as higher opportunities in this case. However, low opportunity areas might be very important locally, and therefore should not be overlooked.

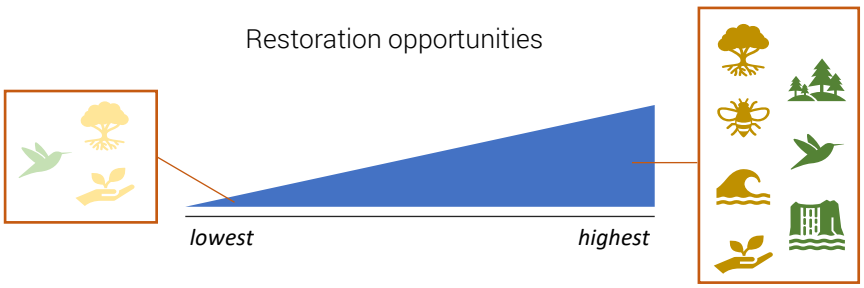


**Figure 3: Schematic representation of the restoration opportunity ranking.** Icons representing biodiversity and Nature's Contributions to People assets potentially benefiting from restoration are shown to provide examples illustrative of low and high restoration opportunity sites. The presence of an icon at the site indicates that the asset would benefit from the restoring of the site. The colour intensity of the icon represents the amount in which the asset would benefit - dark colour: large amount, light colour: small amount.

## Limitations

There are inherent limitations associated with the restoration opportunities layer that relate to its scope and creation methodology. It is important to understand the limitations of using this spatial layer when using it to guide restoration efforts:

1. Due to the broad-scale nature of the spatial data used to create the layer, restoration opportunities need to be verified on-the-ground, including in consultation with local stakeholders and rights-holders. At the local level, the spatial data could be complemented with sex-disaggregated socio-economic data which would more accurately help to determine if women and men from local populations would benefit from the proposed restorations efforts.
2. In its current form, the layer does not consider land tenure or rights. When partners are further exploring opportunities for restoration at the local level, land tenure should always be considered before decision making. It is vital to recognise, uphold and promote the rights of all right-holders, including women, and Indigenous Peoples and local communities. This includes recognising and supporting existing governance systems and their rights to participate in decision-making processes. All project stages, including scoping and restoration action on the ground, should be undertaken following the principles of Free, Prior and Informed Consent (FPIC).
3. In its present format, benefits for species are based on richness of species weighted to emphasise the regions that could restore the distribution of rare species. Therefore, species richness is emphasised over other aspects of species diversity such as complementarity and ecological representation.
4. While the current layer includes benefits for climate change mitigation and adaptation as targets (namely, carbon sequestration and coastal protection, respectively), the methodology does not take into account other potential aspects of climate change on the locations identified to provide the highest opportunities for restoration such as the impact of future climate change on biodiversity and Nature's Contributions to People.

## How can partners access the layer?

Proteus Partners can access the restoration opportunities layer here.

# Next steps

This restoration opportunities layer for Europe is the first of a series of layers that will be developed over the next few years. It has been designed based on the restoration needs and interests of Proteus Partners and uses state-of-the-art spatial optimisation methods adapted from high-impact conservation planning scientific literature. The methodology would continue to be reviewed and improved over subsequent years considering the evolving literature and best practises for spatial prioritisation as well as feedback from Proteus Partners. Therefore, the methods used in the layers we create for other regions may differ from those outlined in this technical brief, in order to most effectively capture the specific restoration opportunities based on variables and potential benefits specific to different regions.

Identifying areas for restoration that provide co-benefits for biodiversity, climate and diverse groups of people is a shared need of the private sector and policymakers. This work allows Proteus Partners to undertake scoping and screening to identify where broad-scale restoration opportunities are available across Europe that would also deliver multiple benefits.

Proteus Partners are invited to provide feedback on this layer based on their user experiences. Any feedback is highly valued to inform further development of the suite of restoration opportunity layers. To provide feedback, or request support in using or interpreting the layer, please get in touch on the Proteus email address, proteus@unep-wcmc.org.

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## Annex 1: Extended Methodology

We ranked restoration priority across areas in Europe that are potentially available for restoration action based on their potential contribution to regional biodiversity recovery and increase in the provision of Nature's Contributions to People, where these are in deficit. We used the spatial prioritisation tool Prioritizr[1] in the programming environment R[1] to identify priority areas, using the spatial data and settings described in this section.

### 1. Target area

We mapped areas in Europe that are potentially available for restoration action as those areas that are not under current production activity or built up, or that are not fully undisturbed (i.e., areas that display an intermediate level of anthropogenic pressure). In the rest of this document, we refer to this area as restoration opportunities area in Europe. Areas in Europe that are built up or are under current production activity were identified based on a land cover raster from the Copernicus Global Land Service[2, 3] by sub-setting pixels from either (i) cultivated and managed vegetation/agriculture or (ii) urban/built up land cover class. We used the land cover classification for 2019, the most recent year available. We then used a layer of human anthropogenic pressure, the human footprint[4], to exclude areas with a very low or very high pressure (areas with a human footprint lower than the percentile 20 or higher than the percentile 80). We used the human footprint layer for the year 2013, which is the most recent year available for commercial use. Only the European part of Russia has been considered for this layer.

### 2. Restoration benefit features

We compiled spatial data for a group of assets indicating the potential biodiversity or Nature's Contributions to People value of sites across Europe, if these were restored. Specifically, we used five biodiversity datasets ((i) potential species richness, (ii) habitat in ecoregion, and area in (iii) salt marshes, (iv) Ramsar sites and (v) Key Biodiversity Areas (KBAs) in restoration need), and five Nature's Contributions to People datasets (potential (i) carbon in vegetation biomass, (ii) water quality regulation, (iii) pollination, (iv) coastal protection, and (v) distribution of plant species with documented human use).

**Potential species richness (biodiversity).** We obtained a map of potential rarity-weighted species richness for native species of birds, mammals and amphibians built from IUCN's Red List version 2021-3[5]. The layer was produced from species' Extent Of Occurrence, which means it is not refined by current habitat and hence can be used as a proxy of their potential distribution if habitats were restored and is available at 10 $km^2$ resolution.

**Ecoregion habitat (biodiversity)**. We subset the global map of ecoregions from Dinerstein et al.[6] to Europe's potential restoration area. We treated each ecoregion as a separate layer. A total of 50 ecoregions had distribution over the study area.

**Area in salt marshes in restoration need (biodiversity)**. We used the distribution of salt marshes habitat within Europe's potential restoration area[7].

**Area in Ramsar sites in restoration need (biodiversity)**. Ramsar sites are wetlands of international importance under the Ramsar Convention[8]. We added the distribution of Ramsar sites[9] within Europe's candidate restoration area (i.e., area within Ramsar sites with high anthropogenic pressure) to drive restoration priorities towards these sites.

**Area in Key Biodiversity Areas in restoration need (biodiversity)**. Key Biodiversity Areas (KBAs) are internationally designated areas of importance for biodiversity conservation[10]. Some KBA area falls within sites under anthropogenic pressures. We used the distribution of KBA sites[11] to favour their selection within restoration high priority areas.

**Potential increase carbon in vegetation biomass (Nature's Contributions to People)**. The layer by Walker et al.[12] indicates the potential, unrealised, increase of carbon stored in vegetation biomass (dataset for baseline conditions), subset at Europe and is aggregated to reflect the increase for area units in analysis.

**Potential to reduce water quality regulation service deficit (Nature's Contributions to People)**. We used the deficit in vegetation's nitrogen retention potential, a measure of the water quality regulation Nature's Contributions to People, as modelled in Chaplin-Kramer et al [13]. This layer indicates the difference between the total water regulation needed by the population of an area and the amount of service that the current vegetation is able to provide.

**Potential to reduce pollination service deficit (Nature's Contributions to People)**. We used the deficit in pollination service as modelled in Chaplin-Kramer et al.[13]. This layer reflects the difference between the amount of pollination required by current croplands in an area and the total service that the current vegetation is able to provide by supporting populations of native pollinator species.

**Potential to reduce coastal protection service deficit (Nature's Contributions to People)**. We used the deficit in coastal protection service as modelled in Chaplin-Kramer et al.[13]. This layer measures the difference between the total protection service that a coastal area requires given its exposure conditions, and the service that current vegetation provides.

**Potential to recover distribution area for plant species with documented human use (Nature's Contributions to People)**. We included maps for the potential distribution of 1215 plant species used by humans for: genetic resource, environment, medicine, weed, forage, material, food, poison, additive, fuel, social uses, and pesticide. The list of plants and their potential distribution was obtained from Khoury et al.[14], who modelled species distributions based on bioclimatic data.

Nature's Contributions to People data (including individual plant species distributions) were split at the country level to generate separate layers for the distribution of each asset in a European country. By using country-level NCP data we ensured that priorities are distributed across countries, contributing to a spread of priorities that promotes an equitable access to Nature's Contributions to People.

Layers were aggregated to a common grid (40 km side area). Data was projected to a Lambert equal area projection to ensure that the area of grid cells, used as a proxy for cost in the prioritisation algorithm (see next section) was constant across the study area. All analyses were conducted in R 4.2[15] using the *terra* library[16].

## 3. Prioritisation settings

The restoration priority ranking was produced using the R library *prioritizr* v7.2.2.6[1]. Prioritizr uses integer linear programming (ILP) techniques to provide solutions to conservation planning problems, including restoration. ILP has been used in the past in the scientific and policy literature to identify restoration opportunities[17] [18]. We defined the conservation problem as a minimum shortfall problem, in which the algorithm aims to maximise the reduction of feature's predefined targets within an area (i.e., to obtain the maximum benefit for each feature within an area). Following Jung et al.[19], we produced the ranking by identifying nested solutions identifying the optimal area with growing percentages of area: top restoration priorities were those identified within the 5% of Europe's potential area with a higher priority, which was nested in the 10% of area. We increased the area until 100% in 5% intervals.

Problems were solved using the *lpsymphony* solver[20] with a 1% maximum gap to optimality.

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**Authors:** Fajardo, J., Bhattacharjee, A., Beard, S., Upton, J., Kamath, V., Dawkins, K., Telhado, C., Ross, A., and Baggaley, S.

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**Available online at**: www.proteuspartners.org

**Contact**:
Anushree Bhattacharjee, Programme Officer, Nature Restored, UNEP-WCMC. Email: anushree.bhattacharjee@unep-wcmc.org, Proteus (proteus@unep-wcmc.org).