Mapping Europe’s primary forests — and identifying how to protect and restore them

Forests with minimal history of human interference — ‘primary forests’ — provide vital ecosystem services and have high levels of biodiversity. These forests are being lost worldwide, even in regions where forests are expanding, and are particularly scarce in Europe. This study uses modelling and maps of forest cover in Europe to determine how primary forest is distributed across the region, with the findings highlighting areas of forest that should be prioritised for restoration and protection.

Primary forests naturally regenerate and are composed of native species. The ecological processes occurring within these forests have experienced little disruption — something vital for conserving their biodiversity.

For the purposes of this study, the researchers define a ‘primary forest’ as one where signs of human impacts (such as coppicing, burning, partial logging) are absent or blurred due to decades (at least 60–80 years) without forestry operations — a definition that aligns with that of the UN’s Food and Agriculture Organization. The study aims to extend current knowledge of Europe’s primary forests by identifying a) which of the 54 forest types in Europe still have primary forest; b) where secondary forest can be restored; and c) opportunities to expand protected areas to encompass primary forest at risk. Primary and old-growth forest conservation is a priority for the UN’s Convention on Biological Diversity and the EU’s Biodiversity strategy for 2030. This research could, therefore, help identify how best to achieve this objective.

The researchers used an innovative geodatabase with maps of primary forest cover, potential natural vegetation, biogeographic regions and protected areas to determine the proportion of existing primary forest across Europe’s many different forest types — and to identify gaps in protection. This map covers 1.4 million hectares of primary forest across 32 European countries (excluding Russia). The researchers used a model to predict primary forest locations, accounting for underreporting of primary forests, and highlighting areas where secondary forest could be restored to complement primary forest protection.
The researchers found great variance in the level of primary forest present in different forest types. They considered 13 broad forest categories (e.g., mountain beech, coniferous Mediterranean or floodplain forest) across Europe’s biogeographical regions (e.g., alpine, boreal and Atlantic). Out of the 54 existing combinations, six no longer contain primary forest and two-thirds have less than 1% remaining. Primary forests occurred more frequently at high elevations and in cold, wet conditions and on north-facing low-productivity terrain.

In terms of protection, only 10 forest types had more than half of their primary forests strictly safeguarded. The mapping showed that, to protect all documented primary forest, current protected areas must be expanded by 1,132 km². Yet only a fraction of Europe’s primary forests is currently documented. If all primary forests, estimated to exist, were to be protected, an extra 19,194 km² of protected areas would be required. In addition, where these forests are currently part of protected areas, the protection regime should be strengthened to ban human activities that could jeopardise natural forest processes.

For forest types where little primary forest remains, restoration to create primary forest structure, composition and functioning in non-primary forests is crucial. The mapping showed that large areas of non-primary forest exist inside protected areas of most forest types, meaning that restoration could be promoted more easily in these areas. Forest restoration could happen either passively (e.g., by setting aside forests from logging or disturbance management); or it may require an active effort (e.g., removing non-native species, translocating species and promoting primary forest structural elements, such as deadwood or veteran trees).

The researchers posit that restoring existing forests to their ecological potential may be a low-cost complement to other land-based solutions (such as reforestation) that help mitigate climate change and biodiversity loss. The study offers an innovative way to identifying areas of primary forest and highlights the importance of protecting them strictly. The findings identify opportunities to protect and restore the structure, composition and function of primary forests, say the researchers. They suggest that, in addition to protecting primary forests and restoring non-primary forests, an integrated forest policy reform is needed to explicitly prevent the loss of Europe’s most valuable forests, due to increased pressures from logging for timber or from climate-change related disturbances.