



Safeguarding old-growth and primary forests: protection and forest landscape restoration to deliver Europe's 30×30 commitments

Anique Hillbrand ^{(a)(*)} - Kathrine Poe ^(a) - Tommaso Demozzi ^(a)

^(a) IUCN, International Union for Conservation of Nature and Natural Resources; Rue Mauverney 28 - 1196 Gland, Switzerland

^(*) Corresponding Author; anique.hillbrand@iucn.org

Abstract: Safeguarding old-growth and primary forests is essential for biodiversity conservation, climate regulation, ecosystem resilience and cultural heritage, yet these forests remain rare, fragmented and increasingly threatened across the EU. Recent assessments estimate that primary and old-growth forests represent <3% of EU forest extent, with substantial gaps in spatially explicit mapping; this rarity underscores the urgency of protection and evidence-based restoration strategies (European Commission 2021b; Sabatini et al., 2018). In alignment with the EU Biodiversity Strategy for 2030, the Kunming-Montreal Global Biodiversity Framework (Target 3, “30×30”) and the EU Nature Restoration Regulation, this paper argues for a dual pathway: (i) protection and improved legal enforcement for remaining intact, high-integrity old and primary forests and (ii) forest landscape restoration (FLR) to strengthen buffer zones, recover old-growth attributes and reconnect landscapes (CBD, Convention on Biological Diversity, 2022; European Union, 2024). We outline governance strategies to harmonize implementation across scales and emphasize the role of participatory management, engaging landowners and communities to strengthen social legitimacy and reduce pressures on remaining forests. Additionally, we suggest practical restoration frameworks, such as the Restoration Opportunities Assessment Methodology (ROAM), that support evidence-based interventions. We conclude with priority actions for conserving primary forests, restoring ecological connectivity, and communicating the ecological, cultural, and socio-economic values of old-growth landscapes. By coupling protection with landscape-scale restoration, supported by robust social safeguards and monitoring, Europe can accelerate progress toward 30×30 targets while enhancing climate resilience and societal benefits.

Key words: old-growth forest; primary forest; protection; forest landscape restoration; 30×30; EU biodiversity strategy; EU Nature Restoration Regulation.

Citation: Hillbrand, A., Poe, K., & Demozzi, T. (2026). Safeguarding old-growth and primary forests: protection and forest landscape restoration to deliver Europe's 30×30 commitments. *L'Italia Forestale e Montana*, 81(2s), 206–215. <https://doi.org/10.36253/ifm-1224>

Received: 24/02/2026 **Revised version:** 15/07/2026 **Published online:** 25/09/2026

1. INTRODUCTION

Old-growth and primary forests represent irreplaceable biodiversity, ecosystem functions and cultural values. EU-level assessments indicate that these forests remain extremely rare: old-growth and primary forests cover less than 3% of total EU forest area and are highly fragmented (European Commission, 2021c; Sabatini et al., 2020).

Robust and harmonized definitions, alongside spatially explicit monitoring, are prerequisites for safeguarding old-growth and primary forests.

For the purpose of this study, the term *primary forests* includes all forests having a high degree of integrity and naturalness, whose structure and dynamics are dominated by ecological and evolutionary processes, without implying that these forests were never cleared nor disturbed by man. This definition is in line with FAO, IUCN (International Union for Conservation of Nature) and CBD (Convention on Biological Diversity) definitions (Buchwald, 2005; CBD, 2021; FAO, 2025; IUCN, 2022).

The post-2020 Kunming-Montreal Global Biodiversity Framework (KM-GBF), adopted at CBD COP15, sets a series of ambitious targets for 2030 aimed at halting and reversing biodiversity loss, including Target 3, which commits Parties to effectively conserve at least 30% of land and sea through protected areas and other effective area-based conservation measures (OECMs) (CBD, 2022). At the European scale, the EU Biodiversity Strategy for 2030 calls for protecting at least 30% of the EU's land and sea areas, with one third of this area (10%) placed under strict protection, of all EU land and sea, including all remaining primary and old-growth forests and the establishment of a coherent trans-European nature network (European Commission,

2020). Building on these commitments, the EU Nature Restoration Regulation (NRR), adopted in 2024, introduces legally binding targets to restore degraded ecosystems, aiming to put restoration measures in place on at least 20% of EU land and sea areas by 2030 and to ensure the recovery of all ecosystems in need of restoration by 2050. The Regulation represents a shift from conservation alone towards active ecosystem recovery, strengthening biodiversity, ecological connectivity and the resilience of European ecosystems (European Union, 2024).

Together, these frameworks necessitate a dual strategy: (i) strict protection of all remaining high-integrity forests and (ii) forest landscape restoration (FLR) to recover buffer zones, structural complexity and ecological connectivity (IUCN & WRI, 2014).

Problem statement: Despite formal protection frameworks, remaining European primary forests continue to face pressures from logging, infrastructure expansion, and other high-impact activities, leading to ongoing degradation of these irreplaceable ecosystems (Barredo et al., 2024). The loss of primary forests not only undermines biodiversity and carbon storage but also reduces the ecological, cultural, and social values that these forests provide. This persistent vulnerability highlights the urgent need for effective strategies that go beyond designation, ensuring both robust protection and the active restoration of degraded landscapes.

Across several European forest regions, including mountain systems and transboundary landscapes, especially in the Scandinavia and Carpathians, that contain some of the continent's most extensive old-growth remnants, analyses and civil-society monitoring have highlighted continued logging and infrastructure pressures affecting forests identified as high-integrity or of primary-forest character.

These situations point to recurring challenges related to enforcement capacity, consistency of environmental impact assessments, interpretation of management categories, and coordination across jurisdictions. These challenges are rooted in the specific context of old-growth temperate and boreal forests in the Global North broadly and Europe specifically, where historical land management practices, cultural forest values, and deforestation trends differ when compared to the tropics, presenting both unique barriers and opportunities.

This paper aims to provide a comprehensive assessment and guidance for conserving Europe's remaining primary and old-growth forests, emphasizing the dual approach of protection and forest landscape restoration. The specific objectives are to:

- Assess current status - Synthesize available knowledge on the extent, condition, and distribution of Europe's high-integrity forests, highlighting data gaps and monitoring advances.
- Review policy frameworks - Examine relevant EU and global policy instruments, including the Biodiversity Strategy for 2030, the Nature Restoration Regulation, and the Kunming-Montreal Global Biodiversity Framework, and their implications for forest protection and restoration.
- Provide practical guidance - Outline actionable strategies for conserving remaining forests, restoring ecological connectivity, and fostering the development of old-growth attributes across landscapes.
- Integrate tools and approaches - Highlight evidence-based methods and frameworks, such as ROAM, remote sensing, and participatory governance, to support planning, implementation, and adaptive management of restoration interventions.
- Promote societal engagement - Emphasize the ecological, cultural, and socio-economic

values of old-growth forests and suggest approaches to communicate these benefits to policymakers, landowners, and the public, reinforcing support for long-term conservation and restoration outcomes.

2. WHY PROTECTION AND FOREST AND LANDSCAPE RESTORATION?

2.1 *The irreplaceable value of primary and old-growth forests*

Primary and old-growth forests store disproportionately high carbon stocks, harbour unique biodiversity assemblages, and regulate hydrological and microclimatic processes in ways not replicated by plantations or simplified secondary forests (Buchwald, 2005; Sabatini et al., 2020). Their rarity and uneven distribution across the EU reinforce the need for strict conservation (Sabatini et al., 2018; European Commission, 2021).

2.2 *Evidence for protection*

Experience from Europe and elsewhere indicates that protected areas are the most effective mechanism for conserving primary and old-growth forests. In the EU, assessments of high-integrity forests show that legal protection substantially reduces the risk of degradation and loss compared with forests under multiple-use or less restrictive management regimes (European Commission, 2021). Protected forests with clear conservation objectives, long-term monitoring, and effective governance generally maintain higher biodiversity, structural complexity, and carbon stocks (Fischer et al., 2023; Rogers et al., 2022; Sabatini et al., 2020).

At the same time, protection alone can be insufficient, particularly if legal frameworks lack strictness or enforcement mechanisms are weak (European Commission, 2021b). Along-

side strong policy, complementary approaches can enhance outcomes, including the establishment of ecological buffers, connectivity corridors, and collaborative management arrangements with local landowners and communities. Engaging stakeholders in stewardship and sustainable land-use practices helps reduce encroachment, supports the maintenance of ecosystem processes, and strengthens the social legitimacy of conservation measures (Anyanwu et al., 2025; Cumming et al., 2022; Sterling et al., 2017). By combining protection with participatory governance and landscape-scale planning, Europe can ensure that remaining primary and old-growth forests are not only preserved on paper but continue to deliver ecological and social benefits over the long term.

2.3 *Why FLR is indispensable*

Even with rigorous protection, Europe must restore landscape connectivity, integrity and resilience. FLR is a people-centred, landscape-scale approach designed to enhance ecological functionality and human well-being through mosaics of restoration interventions, including natural regeneration, enrichment planting, riparian buffers and agroforestry (IUCN & WRI, 2014). Restoration is essential for regenerating “secondary old-growth” attributes, such as large trees, multilayered canopies and deadwood - over policy-relevant timeframes (Pugh et al., 2019).

Furthermore, restoration can establish buffer zones around primary forest fragments and restore connectivity, inhibiting threat encroachment, diverting anthropogenic pressures, and increasing integrity and ecosystem functioning in surrounding landscapes (Götmark et al. 2000; Mayhew et al. 2019; Thorell & Götmark, 2005). Restoring corridors between fragments can also improve wildlife movement and genetic diversity while

reducing edge effects, including susceptibility to invasive species (Bluhm et al., 2023; Estreguil et al., 2012; O’Brien et al., 2025). Subsequently, FLR provides an essential tool for confronting extinction debt faced by primary forests - and for achieving multilateral targets complementary to 30x30, including Target 2 of the GBF to “Ensure that by 2030 at least 30 per cent of areas of degraded terrestrial, inland water, and coastal and marine ecosystems are under effective restoration, in order to enhance biodiversity and ecosystem functions and services, ecological integrity and connectivity.”

3. THE STATE OF PLAY IN EUROPE

3.1 *Extent and data gaps*

Synthesis studies estimate <3% of EU forest area qualifies as primary or old-growth, with major mapping gaps (~4.4 Mha) and pronounced geographic clustering for instance in Sweden, Bulgaria, Finland and Romania (Sabatini et al., 2020). The EPFD 2.0 database highlights substantial advances but also persisting challenges in ensuring comparability of definitions, forest masks and disturbance datasets (European Commission, 2021b).

3.2 *Policy drivers and obligations*

The EU Biodiversity Strategy mandates 30% protection of land and sea, with one-third under strict protection, explicitly including all remaining primary and old-growth forests (European Commission, 2020). The implementation of this target was followed by a Staff Working Document on Guidelines for Defining, Mapping, Monitoring and Strictly Protecting EU Primary and Old-Growth Forests, which supports the implementation of the goal. The EU Nature Restoration Reg-

ulation establishes binding ecosystem-restoration obligations for 2030-2050 (European Union, 2024). Within this legislation, Article 12 specifically deals with the restoration of forest ecosystems. These align with the requirements of the Kunming-Montreal GBF Target 2 on restoration and 3 on conservation (CBD, 2022).

3.3 *Monitoring advances*

Europe's capacity to monitor forest extent and condition has improved markedly through advances in Earth observation and integrated datasets. The EU Deforestation Observatory provides 10-m resolution forest-cover change data and spatially explicit drivers of loss for 2016-2022, enabling more timely detection of degradation, biomass loss, and structural change in old-growth forests (European Commission, 2023). Sentinel-1 and Sentinel-2 time series further support identification of subtle disturbances, including selective logging and canopy thinning.

Emerging approaches also focus on forest structure, age, and continuity, using LiDAR, biomass maps, and long-term disturbance chronologies to probabilistically identify primary forests (European Commission, 2021b). Nevertheless, remote sensing cannot fully capture compositional attributes, deadwood dynamics, or fine-scale management legacies, and inconsistencies in national inventories and definitions of "naturalness" challenge cross-country comparability.

Future integration of remote sensing with ground data, citizen science, and legally binding reporting under the EU Nature Restoration Regulation can strengthen monitoring and early-warning systems, translating technological advances into effective protection of Europe's remaining old-growth forests.

4. A PRACTICAL FRAMEWORK FOR EUROPE: FROM PRINCIPLES TO PRACTICE

4.1 *Protection of and law enforcement in high integrity forests*

The protection of Europe's remaining primary and old-growth forests remains a key priority. Efforts to map and strictly protect these areas, with the help of the framing provided by the IUCN Protected Areas Management categories, provide an important foundation for conservation (IUCN, 2004; Stolton et al., 2013). Protection is most effective when it extends beyond designated boundaries, with ecological buffers and connectivity between forest patches helping to maintain core habitats, reduce fragmentation, and limit the impact of high-intensity activities such as salvage logging or infrastructure development (European Commission, 2021).

Initiatives with a restoration and rewilding dimension are emerging in the EU region; for instance, Rewilding Europe's Nordic Taiga landscape seeks to reinstate natural processes and connectivity across northern Swedish forests, offering models for scaling up process-based restoration beyond isolated reserves. The Scandinavian case underline that restoration strategies which integrate strict protection, natural regeneration, and landscape connectivity are critical to re-establishing old-growth structures and associated biodiversity across boreal and temperate forest regions (Rewilding Europe, 2025)

However, despite clear legal frameworks and designation of high-integrity forests, enforcement or policy loopholes remains inconsistent across Europe. Even in Scandinavia, often regarded as a stronghold of boreal forests, enforcement and protection of high value forests face ongoing challenges. Concerns were mentioned in Sweden and Finland regarding legal and regulatory gaps that may allow log-

ging in areas of high conservation value, including primary and old-growth forests, underscoring the need for strengthened safeguards and effective implementation of EU commitments (Roberntz & Suominen, 2025). Logging and other high-impact activities continue in some primary and old-growth forests, highlighting gaps between policy intent and on-the-ground compliance (EuroNatur, 2022; FERN, 2022). Weak monitoring, limited penalties, and fragmented jurisdictional responsibilities can allow illegal or quasi-legal extraction to persist (Knorn et al. 2013; Nolte, 2013). Strengthening enforcement may require coordinated audits, mandatory reporting, higher fines for violations, and rapid-response mechanisms involving both national authorities and independent observers. Integrating enforcement with remote-sensing monitoring and public transparency can ensure that strict protection policies translate into tangible outcomes for Europe's remaining old-growth forests, underscoring the need for strengthened safeguards and effective implementation of EU commitments.

4.2 Forest landscape restoration to grow tomorrow's old growth

Restoration plays a central role in expanding Europe's stock of high-integrity forests and ensuring the continuity of old-growth attributes.

Once disturbed, primary forests may take decades or centuries to fully recover their baseline condition, which is why protection is essential. However, carefully designed restoration interventions can rebuild structural complexity, improve connectivity, and support the emergence of secondary old-growth characteristics over policy-relevant timeframes, including large trees, multilayered canopies, and abundant deadwood (Pugh et al., 2019; Sabatini et al., 2020).

Restoring areas surrounding primary forest patches can afford immediate, critical safe-

guards to fragmented patches (Crouzeilles et al., 2016; Kormos et al., 2018).

Restoration strategies should prioritize natural regeneration, supplemented where appropriate by assisted natural regeneration, enrichment planting, the re-naturalization of riparian zones, and invasive species management (Dyderski & Jagodziński, 2020; IUCN & WRI, 2014). These approaches help maintain native species composition, promote structural heterogeneity, and enhance ecological resilience to climate change and other pressures.

Spatial targeting is critical for maximizing restoration outcomes. Areas of high degradation, fragmentation, and edge density can be identified using remote sensing, national forest inventories, and landscape connectivity analyses (European Commission, 2023; Estreguil et al., 2013). Integrating these datasets allows prioritization of sites where restoration can deliver the greatest ecological benefits, including improved carbon sequestration, biodiversity recovery, and functional connectivity.

Several tools and frameworks support evidence-based restoration planning. The Restoration Opportunities Assessment Methodology (ROAM) provides a systematic approach to identify, prioritize, and evaluate restoration interventions at landscape scales (IUCN & WRI, 2014). Other tools, such as LiDAR-derived structural mapping, biomass monitoring, and long-term field plots, complement ROAM by tracking progress toward old-growth attributes and providing data for adaptive management.

Integrating the concept of rewilding can significantly enhance the restoration of primary forests by promoting ecological processes and species interactions that support long-term ecosystem resilience. According to the IUCN Rewilding Guidelines, rewilding emphasizes restoring natural dynamics, reintroducing key species, and allowing self-regulating ecological processes to occur, rather than solely focusing

on human-managed restoration (Carver et al., 2025). In the context of primary forest restoration, this approach can accelerate the recovery of structural complexity, biodiversity, and functional connectivity, creating forests that more closely resemble their historical, undisturbed states. By aligning restoration efforts with rewilding principles, practitioners can foster ecosystems that are self-sustaining, climate-resilient, and capable of supporting a diverse array of flora and fauna over time.

Monitoring and adaptive management are central to ensuring that restored forests develop old-growth characteristics. Combining Earth observation, remote sensing, and field-based data allows the assessment of structural development, canopy complexity, biomass accumulation, and regeneration patterns over time. This integrated approach provides feedback for management decisions, supports accountability, and ensures that restoration investments translate into tangible ecological and social outcomes.

5. COMMUNICATING VALUE: ECOLOGY, CULTURE AND ECONOMY

Narratives around old-growth resonate with European publics (RECONNECT, 2025). Effective communication can help bridge the gap between technical conservation objectives and public understanding, reinforcing the legitimacy and urgency of both forest protection and landscape-scale restoration. EU policy explicitly links restoration to climate adaptation, disaster-risk reduction and food security (European Union, 2024), offering powerful entry points for broader constituencies. Communicating biodiversity and climate benefits, bio-cultural heritage (e.g., ancient trees, sacred groves) and socio-economic co-benefits such as flood mitigation, water regulation and

well-being may increase issue salience and therefore political support among both the public and policymakers.

Importantly, ecological, socio-economic, and cultural benefits and trade-offs of primary forest protection and FLR could be reconciled with Europe's evolving forest values to effectively communicate to the public and promote long-term conservation cooperation (Agnoletti & Santoro, 2015; Moyer et al., 2008). Given that some 60% of EU forests are privately owned, both public and private sectors should be engaged in any large-scale restoration initiatives targeting Europe's forests (European Commission, 2021a; Toto et al., 2025).

6. RESULTS: STATUS, THREATS, AND RESTORATION OPPORTUNITIES

Europe's remaining primary and old-growth forests are limited in extent and highly fragmented. Recent pan-European assessments confirm that these forests cover a small fraction of total forest area, with clusters in Sweden, Finland, Bulgaria and Romania but large gaps in spatially explicit mapping (Sabatini et al., 2021). A harmonized geodatabase of known primary forests compiled from multiple field-based datasets reveals tens of millions of hectares of scattered primary forest patches, most of which have remained free of major disturbance over recent decades yet remain spatially isolated and poorly protected (Sabatini et al., 2021).

Advances in monitoring, including the EU Deforestation Observatory, LiDAR-derived structural mapping, and biomass assessments, now enable more accurate tracking of forest extent, structural complexity, and degradation. These data reveal ongoing pressures: even within legally protected areas, logging and other high-impact activities persist, highlighting gaps in enforcement, fragmented

governance, and limited penalties (EuroNatur, 2022; FERN, 2022). Such pressures threaten biodiversity, carbon storage, and the ecological functions that primary forests provide.

Forest landscape restoration offers a complementary pathway to address these challenges. Priority areas for intervention can be identified using criteria such as degradation level, fragmentation, edge density, and connectivity, supported by tools like the Restoration Opportunities Assessment Methodology (ROAM), remote sensing, and national inventories (IUCN & WRI, 2014; European Commission, 2023). Restoration approaches, which include inter alia natural regeneration, assisted regeneration, enrichment planting, riparian re-naturalization, rehabilitation, and rewilding, can rebuild structural complexity and promote the development of old-growth attributes over time. Integrating monitoring through Earth observation and field plots supports adaptive management, ensuring that restored forests contribute to both ecological integrity and societal benefits. These approaches can ultimately support EU biodiversity frameworks and Europe's GBF commitments, including 30x30.

Ultimately, safeguarding Europe's old-growth forests requires an integrated approach: robust protection of remaining high-integrity forests, evidence-based forest landscape restoration to recover structural complexity and connectivity, and clear communication of ecological, cultural, and socio-economic values. By aligning these strategies, Europe can advance toward its 30x30 targets, enhance climate resilience, and ensure that old-growth forests continue to provide enduring benefits for both nature and society.

REFERENCES

- Agnoletti, M., & Santoro, A. (2015). Cultural values and sustainable forest management: The case of Europe. *Journal of Forest Research*, 20, 438–444. <https://doi.org/10.1007/s10310-015-0500-7>
- Anyanwu, L. E., Felix, O. O., Ejike, I. W., & Anyanwu, I. O. (2025). Environmental governance frameworks and stakeholder engagement mechanisms for effective natural resource management at local levels. *World Journal of Advanced Research and Reviews*, 28(2), 1998–2010. <https://doi.org/10.30574/wjarr.2025.28.2.3808>
- Barredo, J. I., Brailescu, C., Teller, A., Sabatini, F. M., Mauri, A., & Janouskova, K. (2021). *Mapping and assessment of primary and old-growth forests in Europe* (EUR 30661 EN). Publications Office of the European Union.
- Barredo, J. I., Rivero, I. M., & Janoušková, K. (2024). Assessing disturbances in surviving primary forests of Europe. *Conservation Biology*, 39(2), e14404. <https://doi.org/10.1111/cobi.14404>
- Bluhm, H., Diserens, T. A., Engleder, T., Heising, K., Heurich, M., Janík, T., Jirků, M., Klich, D., König, H. J., Kowalczyk, R., Kuijper, D., Mašlanko, W., Michler, F.-U., Neumann, W., Oeser, J., Olech, W., Perzanowski, K., Ratkiewicz, M., Romportl, D., ... Kuemmerle, T. (2023). Widespread habitat for Europe's largest herbivores, but poor connectivity limits recolonization. *Diversity and Distributions*, 29, 423–437. <https://doi.org/10.1111/ddi.13671>
- Buchwald, E. (2005). A hierarchical terminology for more or less natural forests in relation to sustainable management and biodiversity conservation. In *Proceedings: Third expert meeting on harmonizing forest-related definitions for use by various stakeholders* (pp. 111–127). Food and Agriculture Organization of the United Nations.
- Carver, S., Convery, I., Hawkins, S., Hertel, S., Fallon, J., Lyons, K., Beyers, R., Locquet, A., Derham, T., & Kun, Z. (Eds.). (2025). *Guidelines for rewilding*. IUCN.
- Convention on Biological Diversity. (2021). *A review of definitions, data, and methods for country-level assessment and reporting of primary forest: A discussion paper for the Food and Agriculture Organization of the United Nations*. Secretariat of the Convention on Biological Diversity.
- Convention on Biological Diversity. (2022). *Kunming–Montreal global biodiversity framework*. Secretariat of the Convention on Biological Diversity.
- Crouzeilles, R., Curran, M., Ferreira, M. S., Lindenmayer, D. B., Grelle, C. E., & Rey Benayas, J. M. (2016). A global meta-analysis on the ecological

- drivers of forest restoration success. *Nature Communications*, 7(1), 11666. <https://doi.org/10.1038/ncomms11666>
- Cumming, G., Campbell, L., Norwood, C., Ranger, S., Richardson, P., & Sanghera, A. (2022). Putting stakeholder engagement in its place: How situating public participation in community improves natural resource management outcomes. *GeoJournal*, 87(Suppl 2), 209–221. <https://doi.org/10.1007/s10708-020-10367-1>
- Dyderski, M. K., & Jagodziński, A. M. (2020). Impact of invasive tree species on natural regeneration species composition, diversity, and density. *Forests*, 11(4), 456. <https://doi.org/10.3390/f11040456>
- EuroNatur. (2020, 22 aprile). *Destruction of Romania's natural forests: Environmental groups pursue new legal action against Romanian authorities*. Agent Green. <https://www.euronatur.org/en/what-we-do/news/destruction-of-romania-s-natural-forests-environmental-groups-pursue-new-legal-action-against-romanian-authorities>
- European Commission. (2020). *EU biodiversity strategy for 2030: Bringing nature back into our lives* (COM/2020/380 final). European Commission.
- European Commission. (2021a). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions*. European Commission.
- European Commission. (2021b). Barredo, J., Brailescu, C., Teller, A., Sabatini, F.M., Mauri, A. & Janouskova, K., *Mapping and assessment of primary and old-growth forests in Europe*, EUR 30661 EN, Publications Office of the European Union, Luxembourg. <https://doi.org/10.2760/797591>
- European Commission. (2021c). *Forest condition and primary/old-growth forest distribution in the EU* (Joint Research Centre Report). Publications Office of the European Union.
- European Commission. (2023). *EU Deforestation Observatory: Forest cover and drivers dataset*. European Commission.
- European Union. (2024). Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration. *Official Journal of the European Union*, L, 1–55.
- FERN. (2022). *EU enforcement is overdue: Destruction of Romania's Natura 2000 primary and old-growth forests continues*. <https://www.fern.org/publications-insight/eu-enforcement-is-overdue-destruction-of-romania-s-natura-2000-primary-and-old-growth-forests-continues-2465>
- Fischer, H. W., Chhatre, A., Duddu, A., & Caviedes, J. (2023). Community forest governance and synergies among carbon, biodiversity and livelihoods. *Nature Climate Change*, 13, 1340–1347. <https://doi.org/10.1038/s41558-023-01863-6>
- Food and Agriculture Organization of the United Nations. (2025). *Global forest resources assessment 2025: Terms and definitions*. FAO.
- Götmarm, F., Söderlundh, H., & Thorell, M. (2000). Buffer zones for forest reserves: Opinions of land owners and conservation value of their forest around nature reserves in southern Sweden. *Biodiversity & Conservation*, 9(10), 1377–1390. <https://doi.org/10.1023/A:1008978831068>
- International Union for Conservation of Nature. (2004). *Protected area categories*. IUCN. https://iucn.org/sites/default/files/import/downloads/14_3lowres.pdf
- International Union for Conservation of Nature. (2022). *IUCN policy statement on primary forests including intact forest landscapes*. IUCN.
- International Union for Conservation of Nature & World Resources Institute. (2014). *A guide to the Restoration Opportunities Assessment Methodology (ROAM)*. IUCN.
- Knorn, J., Kuemmerle, T., Radeloff, V. C., Keeton, W. S., Gancz, V., Biriş, I. A., Svoboda, M., Griffiths, P., Hagatis, A., & Hostert, P. (2013). Continued loss of temperate old-growth forests in the Romanian Carpathians despite an increasing protected area network. *Environmental Conservation*, 40(2), 182–193. <https://doi.org/10.1017/S0376892912000355>
- Kormos, C. F., Mackey, B., DellaSala, D. A., Kumpe, N., Jaeger, T., Mittermeier, R. A., & Filardi, C. (2018). Primary forests: Definition, status and future prospects for global conservation. In D. A. DellaSala & M. I. Goldstein (Eds.), *The encyclopedia of the Anthropocene* (Vol. 2, pp. 31–41). Elsevier.
- Mayhew, R. J., Tobias, J. A., Bunnefeld, L., & Dent, D. H. (2019). Connectivity with primary forest determines the value of secondary tropical forests for bird conservation. *Biotropica*, 51(2), 219–233. <https://doi.org/10.1111/btp.12629>
- Moyer, J. M., Owen, R. J., & Duinker, P. N. (2008). Forest values: A framework for old-growth forest with implications for other forest conditions. *The Open Forest Science Journal*, 1(1), 27–36. <https://doi.org/10.2174/1874398600801010027>
- Nolte, C., Agrawal, A., Silvius, K. M., & Soa-

- res-Filho, B. S. (2013). Governance regime and location influence avoided deforestation success. *Proceedings of the National Academy of Sciences*, 110(13), 4956–4961. <https://doi.org/10.1073/pnas.1214786110>
- O'Brien, D., Aavik, T., Fedorca, A., Fischer, M. C., Goffaux, R., Hoban, S., Hollingsworth, P., Hvilsum, C., Jehle, R., Kalamujić Stroil, B., Kershaw, F., Klinga, P., Kopatz, A., Leigh, D. M., Paz-Vinas, I., Robuchon, M., Segelbacher, G., Takacs, V., Vernesi, C., & Laike, L. (2025). Restoring genetic diversity to facilitate the implementation of the EU Nature Restoration Law. *Biological Conservation*, 303, 110995. <https://doi.org/10.1016/j.biocon.2025.110995>
- Pugh, T. A., Lindeskog, M., Smith, B., Poulter, B., Arneeth, A., Haverd, V., & Calle, L. (2019). Role of forest age in the global carbon sink. *Nature*, 571(7764), 230–234.
- RECONNECT. (2025). *RECONNECT policy brief: Narratives* [Policy brief].
- Rewilding Europe. (2025, May 8). *Rewilding Europe's Swedish Lapland rewilding landscape becomes Nordic Taiga*. rewildingeurope.com
- Robertz, P., & Suominen, M. (2025). *Primary and old-growth forests at risk in Finland and Sweden: What will the EU's impact be on protecting them?* WWF Finland; WWF Sweden. <https://wwf.fi/app/uploads/t/n/x/oehmxh4q8ikqt692yxj1x/primary-and-old-growth-forests-at-risk-in-finland-and-sweden--what-will-the-eus-impact-be-on-protecting-them-wwf-report-2025.pdf>
- Rogers, B. M., Mackey, B., Shestakova, T. A., Keith, H., Young, V., Kormos, C. F., DellaSala, D. A., Brandt, P., Coad, L., Fitzsimons, J. A., Jaeger, T., & Hugh, S. (2022). Using ecosystem integrity to maximize climate mitigation and minimize risk in international forest policy. *Frontiers in Forests and Global Change*, 5, 929281. <https://doi.org/10.3389/ffgc.2022.929281>
- Sabatini, F. M., Bluhm, H., Kun, Z., Aksenov, D., Aauri, J. A., Buchwald, E., Burrascano, S., Cateau, E., Diku, A., Duarte, I. M., Fernández López, Á. B., Garbarino, M., Grigoriadis, N., Horváth, F., Keren, S., Kitenberga, M., Kiš, A., Kraut, A., Ibisch, P. L., . . . Kuemmerle, T. (2021). European primary forest database v2.0. *Scientific Data*, 8(1), 220. <https://doi.org/10.1038/s41597-021-00988-7>
- Sabatini, F. M., Burrascano, S., Keeton, W. S., Levers, C., Bauhus, J., Korhonen, K. T., Jucker, T., Lohmus, A., Ibisch, P. L., Stojanovic, D., Mikoláš, M., Bisi, F., Chirici, G., Diaci, J., Fekete, G., Grigoriadis, N., Knorn, J., Kozák, D., Matović, B., . . . Kuemmerle, T. (2018). Where are Europe's last primary forests? *Diversity and Distributions*, 24(10), 1426–1439. <https://doi.org/10.1111/ddi.12778>
- Sabatini, F. M., Keeton, W. S., Lindner, M., Svoboda, M., Verkerk, P. J., Bauhus, J., Bruelheide, H., Burrascano, S., Debaive, N., Duarte, I., Garbarino, M., Grigoriadis, N., Lombardi, F., Mikoláš, M., Meyer, P., Motta, R., Mozgeris, G., Nunes, L., . . . Kuemmerle, T. (2020). Where are Europe's last primary forests? *Diversity and Distributions*, 26(12), 1646–1662. <https://doi.org/10.1111/ddi.13158>
- Sterling, E. J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., Malone, C., Pekor, A., Arengo, F., Blair, M., Filardi, C., Landrigan, K., & Porzecanski, A. L. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological Conservation*, 209, 159–171. <https://doi.org/10.1016/j.biocon.2017.02.008>
- Stolton, S., Shadie, P., & Dudley, N. (Eds.). (2013). *Guidelines for applying protected area management categories including IUCN WCPA best practice guidance on recognising protected areas and assigning management categories and governance types*. Best Practice Protected Area Guidelines Series, IUCN. <https://portals.iucn.org/library/node/30018>
- Thorell, M., & Götmark, F. (2005). Reinforcement capacity of potential buffer zones: Forest structure and conservation values around forest reserves in southern Sweden. *Forest Ecology and Management*, 212(1–3), 333–345. <https://doi.org/10.1016/j.foreco.2005.03.028>
- Toto, R., Alix-García, J., Sims, K. R., Coutinho, B., Brenes, C. M., Pugliese, L., & Mendes, A. F. (2025). Evidence on scaling forest restoration from the Atlantic Forest Restoration Pact in Brazil. *Nature Communications*, 16(1), 345. <https://doi.org/10.1038/s41467-025-59194-3>