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Convergence and divergence in science and practice of urban and rural forest restoration

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ABSTRACT

Forest restoration has never been higher on policymakers' agendas. Complex and multi-dimensional arrangements across the urban–rural continuum challenge restorationists and require integrative approaches to strengthen environmental protection and increase restoration outcomes. It remains unclear if urban and rural forest restoration are moving towards or away from each other in practice and research, and whether comparing research outcomes can help stakeholders to gain a clearer understanding of the interconnectedness between the two fields. This study aims to identify the challenges and opportunities for enhancing forest restoration in both urban and rural systems by reviewing the scientific evidence, engaging with key stakeholders and using an urban–rural forest restoration framework. Using the Society for Ecological Restoration's International Principles as discussion topics, we highlight aspects of convergence and divergence between the two fields to broaden our understanding of forest restoration and promote integrative management approaches to address future forest conditions. Our findings reveal that urban and rural forest restoration have convergent and divergent aspects. We emphasise the importance of tailoring goals and objectives to specific contexts and the need to design different institutions and incentives based on the social and ecological needs and goals of stakeholders

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in different regions. Additionally, we discuss the challenges of achieving high levels of ecological restoration and the need to go beyond traditional ecology to plan, implement, monitor, and adaptively manage restored forests. We suggest that rivers and watersheds could serve as a common ground linking rural and urban landscapes and that forest restoration could interact with other environmental protection measures. We note the potential for expanding the creative vision associated with increasing tree-containing environments in cities to generate more diverse and resilient forest restoration outcomes in rural settings. This study underscores the value of integrative management approaches in addressing future forest conditions across the urban–rural continuum. Our framework provides valuable insights for policymakers, researchers, and decision-makers to advance the field of forest restoration and address the challenges of restoration across the urban–rural continuum. The rural–urban interface serves as a convergence point for forest restoration, and both urban and rural fields can benefit from each other's expertise.

Key words: SER principles, restoration ecology, urban forest restoration, rural forest restoration, narrative synthesis, evidence-based research, urban–rural continuum, influence synthesis, evidence synthesis, research outcomes.

CONTENTS

I. INTRODUCTION

Forest restoration has never had a higher profile on the agendas of policymakers, in the activities of non-governmental organisations (NGOs), and in the portfolios of investors (Fagan *et al.*, 2020; de Jong, Liu & Long, 2021). The United Nations General Assembly of 2019 declared 2021–2030 as the 'UN Decade on Ecosystem Restoration' (hereafter referred to as 'The Decade'), following a proposal for action by over 70 countries across all latitudes. The Decade is building a strong movement to ramp up environmental restoration globally, facilitating the timely realisation of the Bonn Challenge targets (an agreement to restore 350 million hectares by 2030), the UN Sustainable Development Goals (SDGs; Edrisi & Abhilash, 2021), and several other ongoing restoration initiatives (Brancalion & Holl, 2020). This has brought forest restoration into the centre of the global discussion on ways to halt biodiversity loss, combat climate change, and improve rural livelihoods (Chazdon & Brancalion, 2019).

Yet, as human interventions escalate across the Earth's biomes (Smith, Hallett & Groffman, 2020), forest restoration has broadened from its traditional focus on rural communities to the rehabilitation of a variety of landscapes, including post-agricultural areas and cities (Klaus & Kiehl, 2021; Rega-Brodsky *et al.*, 2022). Cities worldwide have been also engaging in large-scale greening projects including forest restoration and other tree-planting efforts (Yao *et al.*, 2019; Piana, Pregitzer & Hallett, 2021*b*). Global campaigns to promote action in cities, such as the Trees in Cities Challenge (treesincities.unece.org/), aim to expand urban forests and canopy cover (e.g. Moskell, Allred & Ferenz, 2010; Pincetl, 2010; https://climateaction.tucsonaz.gov/), due to the recognised importance of integrated socioeconomic and environmental policies (Forster *et al.*, 2021). The 2018 UN World Urbanization Prospects report reinforced the importance of integrating policies to improve dwellers' livelihood in both urban and rural areas (United Nations, 2018). Thus, the momentum is unique for policy-makers across geopolitical and ecological scales to contribute to the targets of the UN Decade.

Although rural and urban forest restoration share a common goal – that of restoring diverse and functional ecosystems – they seem to occupy different realms. Urban green spaces are in general more heavily modified than their rural counterparts (Walsh *et al.*, 2005), including a range of ongoing disturbances. Notably, restoration in cities typically occurs over much smaller areas than in rural landscapes, hence ongoing management (e.g. on the part of municipal services) and intensive human use (e.g. in the form of unregulated recreation) can be expected. More crowded (Ziter *et al.*, 2019) and structured by humans than surrounding landscapes (Pouyat & Carreiro, 2003), the unique characteristics of urban spaces mean that they may require novel approaches to restoration (Smith *et al.*, 2020). In addition, restoration in rural and urban spaces is likely to be motivated by contrasting objectives and goals, and could deliver different types of benefits. Some environmental benefits, like preventing species extinctions and massive carbon sequestration, rely on the restoration of very large and less-modified areas to achieve relevant outcomes (i.e. they are maximised in rural restoration). Alternatively, some other benefits will depend more on the proximity of large human populations, like many cultural ecosystem services (i.e. they may be maximised in urban restoration). As a result, rural and urban spaces may have different levels of potential supply and demand for varying ecosystem services.

Academically, scholars that explore restoration projects and ecology in rural and urban settings frequently work in separate departments or institutes, publish in (and read) different journals, use different terminology (e.g. Shaw, Roche & Gornish, 2020), and participate in different conferences. Moreover, and in contrast with rural forest restoration, the scientific knowledge and basic systematic framework required to inform successful forest restoration and management are largely lacking in urban settings (Wallace & Clarkson, 2019; Piana *et al.*, 2021*b*). Hence, as the field of urban forest restoration matures, it is currently unclear whether it is converging with its well-established sibling field of rural forest restoration, or if potential divergences in science and practice are leading to further differentiation between the two. By conducting a comprehensive examination of research results, stakeholders may gain a clearer understanding of the interconnectedness between urban and rural forest restoration. This understanding can orient efforts more effectively and optimise policies that maximise restoration outcomes.

Here, we present an urban–rural forest restoration framework through which we synthesise recent evidence and engage with key stakeholders (researchers and decision-makers) globally to identify challenges and opportunities for advancing forest restoration science and practice in both urban and rural systems. We use the International Principles (hereafter referred to as 'The Principles') for the practice of ecological restoration from the Society for Ecological Restoration (SER; Gann *et al.*, 2019) as a way to highlight points of convergence and divergence in science and practice between the two systems. We address eight topics based on The Principles: (*i*) Stakeholder engagement; (*ii*) Types of knowledge; (*iii*) Target ecosystems; (*iv*) Ecosystem recovery process; (*v*) Goals, objectives, and indicators; (*vi*) Achieving a high level of recovery; (*vii*) Cumulative ecological values; and (*viii*) the Continuum of restorative activities. Our synthesis addresses the following question: how can the sibling fields of urban forest restoration – with a short tradition – and rural forest restoration – with a long history – be characterised and understood such that synergies and convergences can be identified to advance both? We conclude by discussing perspectives to accommodate rural and urban forest restoration together into a larger forest restoration framework, envisioning a more ecologically functional territory and increased socio-ecological outcomes.

(1) Defining forests, and urban and rural forest restoration

Defining 'forest' is crucial to formulate operational frameworks that might be used in decision-making (van Noordwijk & Minang 2009) or research development (Chazdon *et al.*, 2016; de Jong *et al.*, 2021). But the term 'forest' can be controversial. The FAO (2000) definition describes forests as an area of at least 0.5 ha with trees at least 5 m high at maturity *in situ* and with tree crown cover (or equivalent stocking level) of at least 10%, or trees that will in time reach these criteria (GFRA, 2015; Chazdon *et al.*, 2016; de Jong *et al.*, 2021).

In cities, the term 'urban forest' is commonplace and is often used to refer to 'all trees in the city' (Konijnendijk *et al.*, 2006; Piana *et al.*, 2021*b*) – a definition that is aligned with urban tree canopy and does not distinguish between site type and structure (NUCFAC, 2015). While this definition has been important for establishing city-scale greening goals, it obscures fundamental differences in the ecology and management needs of different site types. Piana *et al.* (2021*b*) suggest subcategories of urban forests based on structure and management (Fig. 1). Each subcategory requires distinct restoration and management approaches, which vary in terms of intensity, timeframe, ownership/governance, extent, and provided ecosystem services.

A similar gradient may be found in rural areas, resulting from a complex integration between varying structures and compositions (Fig. 1). Yet, unlike urban forests, the 'all trees' definition is not commonplace in rural settings, and forest is typically seen as a discrete habitat type. A more comprehensive concept of 'forest' than the dominant FAO definition could help advance an inclusive approach to forest restoration (e.g. considering the urban–rural gradient) (GFRA, 2015; Chazdon *et al.*, 2016). Hence, we consider herein a diverse set of forest definitions, trying to capture this broad forest concept in most of its dimensions across the urban–rural landscape (Fig. 1).

Defining 'forest restoration' is equally challenging, mainly because this task encompasses diverse objectives, and socio-ecological conditions (Stanturf, 2005). In a broad sense, and

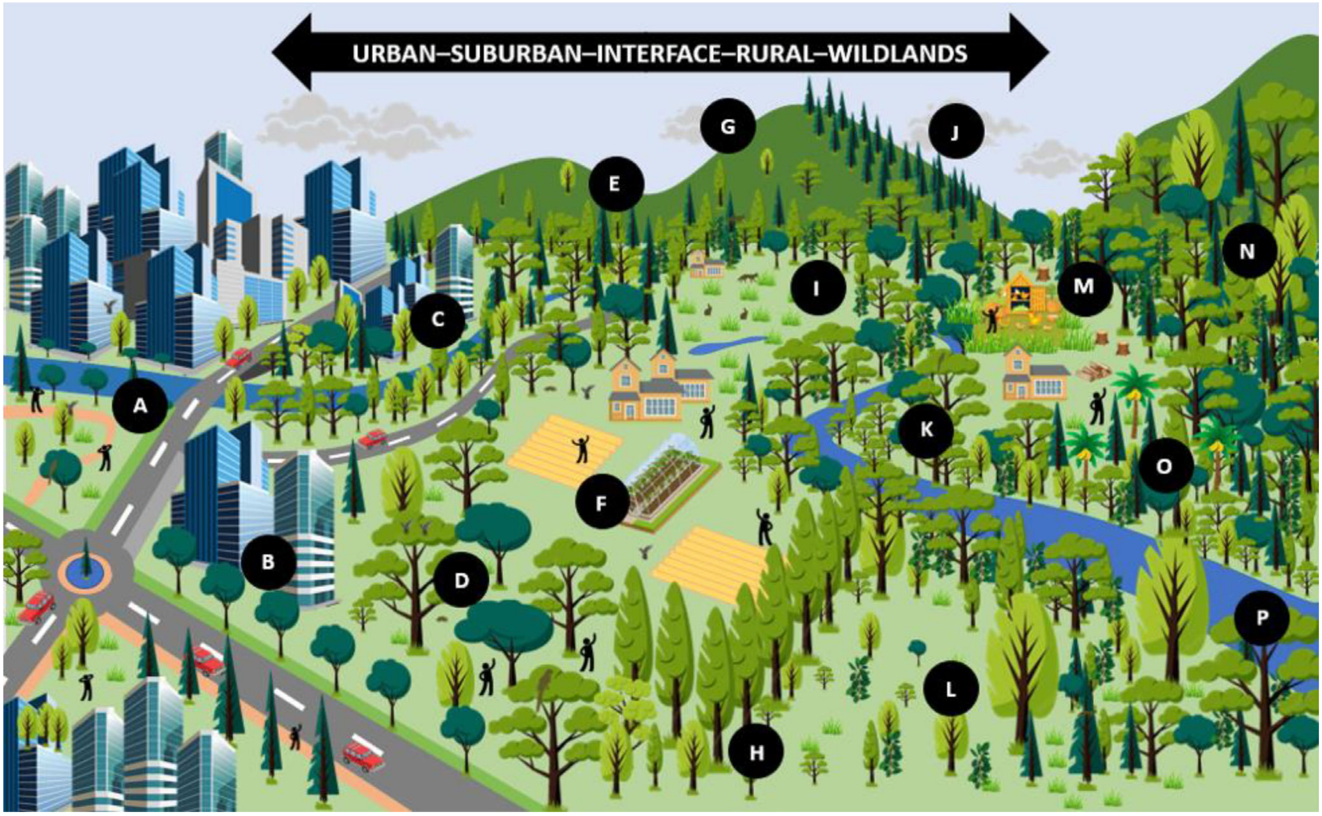

Fig. 1. Schematic view of trees and forests across the urban–rural gradient. This landscape encompasses several conceptual components: (A) urban park for leisure and recreation activities, also stabilising slopes and riverbanks; (B) individual trees lining the street contributing to offset heat islands (and reducing energy bills), and supporting human health and local wildlife; (C) restoration of remaining urban riparian forest patches creating a biological corridor and connecting forest fragments; (D) forests within and surrounding cities contributing to cleaner air and drinking water, absorbing rainfall, thus reducing flooding, and offering refuge from urban life; (E) restoration improving urban–rural landscape connectivity (e.g. wildlife corridors); (F) urban–rural intersection, with food production; (G) isolated trees in pastures; (H) trees creating alleys within which agricultural or horticultural crops are produced; (I) mosaic of trees and non-forested habitats; (J) commercial monoculture tree plantation; (K) restored riparian forest creating a biological corridor connecting remaining forest patches in rural landscapes; (L) naturally regenerating area, adjacent to extant native forest that provides seed rain for natural regeneration; (M) restored forest, which might include useful non-invasive exotic species for timber and non-timber forest products, where people monitor biomass and biodiversity recovery; (N) protected existing native forests, either old- or second-growth, where native seeds can be collected – these forests sequester large amounts of carbon, generate rain for the world's farm belts, provide useful products, and host the majority of the world's land-based biodiversity; (O) agroforests to create environmental, economic, and social benefits; (P) natural forest with different levels of disturbance.

echoing De Jong *et al.* (2021), forest restoration refers to the intervention with a goal of bringing back forest where it has disappeared or restoring the conditions of forests to how they were before degradation had occurred. Burton & Ellen Macdonald (2011) argue that forest restoration embraces a wide range of activities that enhance forest ecosystem services or nudge degraded forests to a more 'natural state' (see Table 1). Terms that have been used across the literature with somewhat similar meanings are forest rehabilitation, reforestation, and afforestation (Burton, 2014; Table 1). Forest restoration may also include different methods and techniques (Rodrigues *et al.*, 2009; Klaus & Kiehl, 2021; Romanelli *et al.*, 2022), and this has been extensively discussed elsewhere (e.g. Burton & Ellen Macdonald, 2011; Stanturf, Palik & Dumroese, 2014).

For describing different restoration targets and levels of intervention for improving environmental conditions of urban ecosystems, Klaus & Kiehl (2021, p. 84) elaborated a recent conceptual framework where they propose the term 'ecological rehabilitation' to refer to the improvement of a 'habitat with the aim of enhancing ecosystem functions and/or biodiversity but without returning to a historic, pre-disturbance ecosystem state'. They also argue the use of the term remediation – the removal of litter and pollutants – as the first step in improving the abiotic conditions of extremely degraded ecosystems in urban areas.

Table 1. Glossary of key terms.

Afforestation	Refers to the establishment of continuous tree cover after land conversion on land where there has not been a forest before or has not been a forest for a significant timespan, independent of species composition (Burton, 2014; de Jong *et al.*, 2021).
Ecological restoration	In its strictest sense, can be defined as the 'process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed' (https//www.seraustralasia.org/). In principle, ecological restoration is acknowledged as best practice for achieving outcomes for both people and nature (Guerrero *et al.*, 2015).
Forest landscape restoration (FLR)	A relatively new approach that has been used to define the process of regaining ecological functionality and enhancing human well-being in rural deforested landscapes (https://infoflr.org/what-flr) and embraces a broad range of 'restorative practices' that include ecological restoration, agroforestry, and monoculture tree plantations, among others (Sabogal *et al.*, 2015).
Reforestation	Usually refers to establishment of continuous tree cover after deforestation on land where forest had existed until recently, regardless of the species composition or desirable functional aspects (Burton, 2014; de Jong *et al.*, 2021).
Rehabilitation	Refers to efforts to restore desired species composition, structure, or processes to an existing, but degraded, ecosystem in relation to a pre-disturbance, reference condition (Chokkalingam *et al.*, 2005; Stanturf *et al.*, 2014).
Natural state	The idea of a 'natural state' in the context of forest restoration is complex. Establishing precise criteria for what constitutes a natural forest is subjective and lacks widespread agreement. However, pristine forests or other reference systems can serve as benchmarks. Forests exhibit complex variations in structure, species composition, and disturbance history. Past human activities, invasive species and climate change also introduce complexities. The term 'natural' also encompasses social and cultural dimensions, as stakeholders hold diverse perspectives influenced by their values and desired outcomes (Burton & Ellen Macdonald, 2011; Chazdon *et al.*, 2016).

For our purposes, we navigate between broader and narrower definitions of forests and forest restoration. The broader concepts aim to provide alternatives for the unification of urban and rural ecosystems under one forest restoration framework. In that sense, we present broad forms of tree assemblages as restorative activities allied to ecological restoration (e.g. street trees in urban systems, or alley trees in rural landscapes). Nonetheless, we acknowledge that some assemblage types will be limited in their provisioning of ecosystem services when compared to large multi-species reforestation or ecological restoration projects. Importantly, this raises the question of whether all greening efforts (e.g. street trees in cities) can be considered 'true restoration'. We recognise that the discussion around definitions of vague terms can lead to debate but we proceed with a broad working definition as described above. Finally, we acknowledge that the SER principles cover both more general and specific topics in the context of ecological restoration, some of which can be used in myriad restoration approaches (e.g. stakeholder engagement, and types of knowledge), while others are better suited to the context of ecological restoration in its strict sense (e.g. the ecosystem recovery process, and achieving a high level of recovery).

Restoration and silviculture – 'the art and science of controlling the composition, structure, and dynamics of forests' (Putz, 2004, p. 1039) – seemingly overlap without clear separation (Wagner *et al.*, 2000; Sarr & Puettmann, 2008); certainly, restoration uses many techniques common to silviculture (Stanturf *et al.*, 2014). Severely degraded, damaged, or destroyed forest ecosystems require extraordinary effort, distinguishing restoration of deforested land from normal forestry practices of regenerating a new stand following harvest or other disturbances (Stanturf, 2005; Putz & Redford, 2010). Once underlying ecological processes are functioning, many restored forests can be managed by sustainable silvicultural practices, although novel ecosystems may require adjustments (Lugo *et al.*, 2020; Achim *et al.*, 2022; Girona *et al.*, 2023).

In what follows, we use the term forest restoration to describe efforts that respond to a broad spectrum of needs for forest ecosystem services, such as (*i*) producing forest products (e.g. timber, other wood products, and non-timber products of cultural value) (Sedjo, 1999); (*ii*) creating spaces for leisure and recreation (Brancalion *et al.*, 2013; Elmqvist *et al.*, 2015); (*iii*) conserving and promoting regulatory ecosystem services (e.g. carbon sequestration or filtering pollutants) (Dai *et al.*, 2017; Friedlingstein *et al.*, 2019); and (*iv*) contributing to livelihood improvements (Nguyen *et al.*, 2015; de Jong *et al.*, 2021). We consider forest restoration to be any method of reinstating tree assemblages, including planting, seeding, assisted natural regeneration, or a combination of these methods (*sensu* Hagger, Dwyer & Wilson, 2017; Sarr & Puetmann, 2008).

II. METHODS

We constructed a general framework (Fig. 2) through which we built on current evidence and engaged with key stakeholders – scientists and decision-makers from the forest restoration field – to understand the links between urban and rural forest restoration research and practice.

To characterise the two fields academically, we performed an influence synthesis (Fig. 2; Step 1), including performance analysis and bibliometrics mapping (Nakagawa *et al.*, 2019).

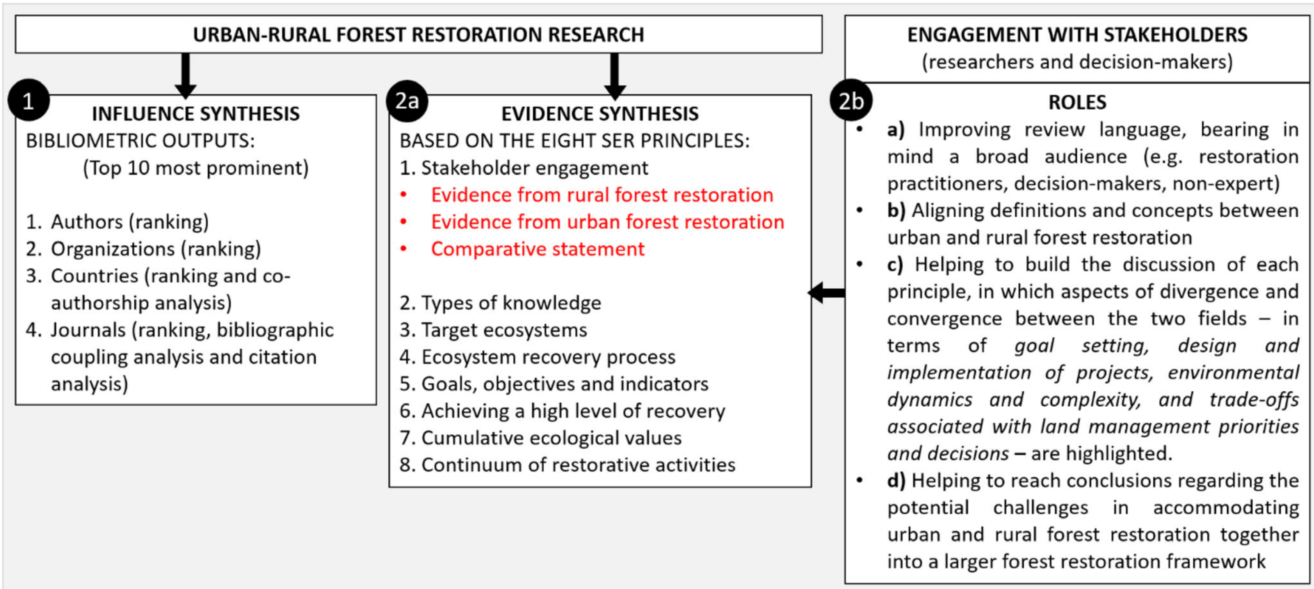

Fig. 2. Overall study framework. Urban and rural forest restoration research is assessed in two different stages. Step 1 displays outcomes and analysis performed in the influence synthesis to characterise the two fields as disciplines. Step 2a shows the overall structure of the evidence synthesis; red text represents the inner structure used to discuss each principle. Step 2b shows the general roles followed by stakeholders to build the discussion of each principle. Steps 2a and 2b were used to understand potential synergies and convergences between the two fields. SER, Society for Ecological Restoration.

Performance analysis accounts for the contribution of individual research constituents (e.g. authors or organisations), whereas bibliometric mapping focuses on the associations between them, and allows evaluation of their interactions (Romanelli *et al*., 2021*a*; Cucari *et al*., 2023). We used the *Web of Science* (WoS) platform [core collection: Science Citation Index Expanded (SCI-E), Social Sciences Citation Index (SSCI), Emerging Sources Citation Index (ESCI)] as a bibliographic source to gather a sample of urban and rural forest restoration-related publications to analyse: (*i*) the performance of authors, countries, organisations and journals in terms of research productivity (rankings); (*ii*) bibliometric mapping of the 10 the most productive countries and organisations through co-authorship analysis (i.e. based on their number of co-authored documents); (*iii*) bibliometric mapping of the 10 most influential journals through co-citation analysis (i.e. based on the number of times they were cited together) and bibliographic coupling (i.e. based on the number of shared references) (van Eck & Waltman, 2010; Romanelli *et al*., 2018). Since the term 'forest restoration' is used indiscriminately and is challenging to define in a way that applies to all situations observed in practice and science (Ciccarese, Mattsson & Pettenella, 2012), we selected multiple terms to build search strings and performed separate searches for each field (i.e. urban *versus* rural forest restoration) (see online Supporting Information Appendix S1 for the search strings used).

To understand potential synergies and convergences between the two fields, we conducted an evidence synthesis encompassing the eight SER principles (Fig. 2; Step 2a). We also engaged with key stakeholders to help build the discussion of the eight topics (Fig. 2; Step 2b). This evidence synthesis involved gathering, combining, and comparing scientific outcomes (Romanelli *et al*., 2021). First, we briefly discussed and compared research outcomes among urban and rural forest restoration, and then elaborated a comparative statement to highlight aspects of convergence and divergence among the two fields (Fig. 2; Step 2a). We established general roles for all stakeholders to follow, which oriented the evidence synthesis process (Fig 2; Step 2b). The discussion of each principle was led by different authors: Stakeholder engagement, C. A.; Types of knowledge, E. S. G., F. C.; Target ecosystems, P. J. B., K. J. W.; Ecosystem recovery process, P. H. S. B., M. R. P., R. R. R.; Goals, objectives, and indicators, K. J. W., P. A. M.; Achieving a high level of recovery P. H. S. B., M. R. P., R. R. R.; Cumulative ecological outcomes, H. L. D., J. S., P. J. B.; and Continuum of restorative activities, V. H. K., F. C.

III. INFLUENCE SYNTHESIS – BIBLIOMETRIC ANALYSIS

We gathered 20,229 publications related to rural forest restoration and 1091 publications related to urban forest restoration (see online Supporting Information, Appendix S1 and Fig. S1). The most productive authors publishing on forest restoration research differed completely between the two fields (Fig. 3A), indicating a tendency of individual researchers to focus on specific subjects or environments (e.g. rural or urban settings). This is consistent with previous findings that authors' contributions to research tend to reflect their subject

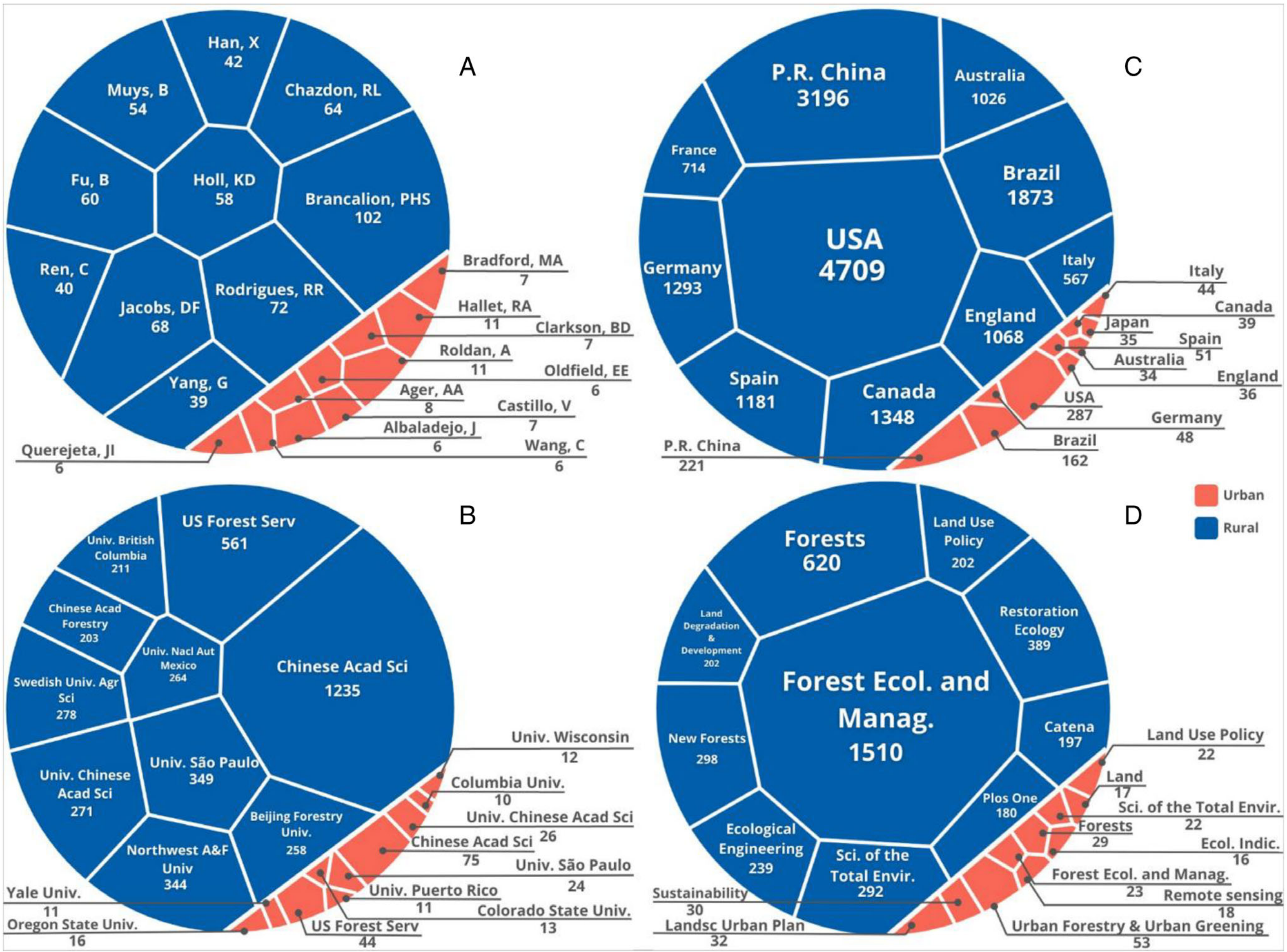

Fig. 3. Rankings of top 10 authors (A), organisations (B), countries (C) and journals (D) publishing in rural (blue) and urban (red) forest restoration, in terms of the number of publications.

specialisation (Joshi, 2014). However, we found a few authors that did cross the boundaries of the two disciplines, engaging in expanded collaborative networks beyond their main research focus, perhaps to leverage the ecological connections between the two systems (McDonnell & Pickett, 1990; Alberti, Botsford & Cohen, 2001). In these cases, forest restoration researchers reported studies in both realms, for example, by investigating ecological outcomes or population perceptions of forests in both urban and rural systems (e.g. Muler *et al.*, 2018; Crouzeilles *et al.*, 2020).

By contrast, we found similarities in the most common organisations and countries publishing on urban and rural forest restoration (Fig. 3B,C). Researchers from the USA, China, and Brazil were responsible for the greatest proportion of publications in both fields, developing a large body of literature and with collaborative networks across countries and continents (Fig. 4A,B). Across science, some countries and organisations have a greater influence than others, and this is reflected in the volume of peer-reviewed studies they produce or co-produce (through co-authorship) (Romanelli *et al.*, 2018, 2021*a*).

Analysis of the impact of scientific journals through an examination of their publication frequency, citations, and shared references, enables insight into how the researchers disseminate their results, how the flux of information occurs, and any associations among them (Wildgaard, Schneider & Larsen, 2014) (Fig. 4C,D). While restoration researchers use a wide range of venues to publish their findings (Fig. 3D), there was clear convergence on some journals with a more comprehensive scope (e.g. *Forest Ecology and Management*, and *Forests*) between the two fields. Yet, the two fields also differed in preferences for journals with a more specific focus (Fig. 3D). For example, urban forest restorationists published most often in the journal *Urban Forestry and Urban Greening*. A skewed distribution of journals is expected in bibliometrics (Bradford law) since individual journals generally publish on specific themes, although some publish within a broader research context (Okubo, 1997; Romanelli *et al.*, 2018, 2021*a*).

Investigating the association of journals through citation analysis (e.g. bibliographic coupling and co-citation) can reveal whether more specialised research topics cross the

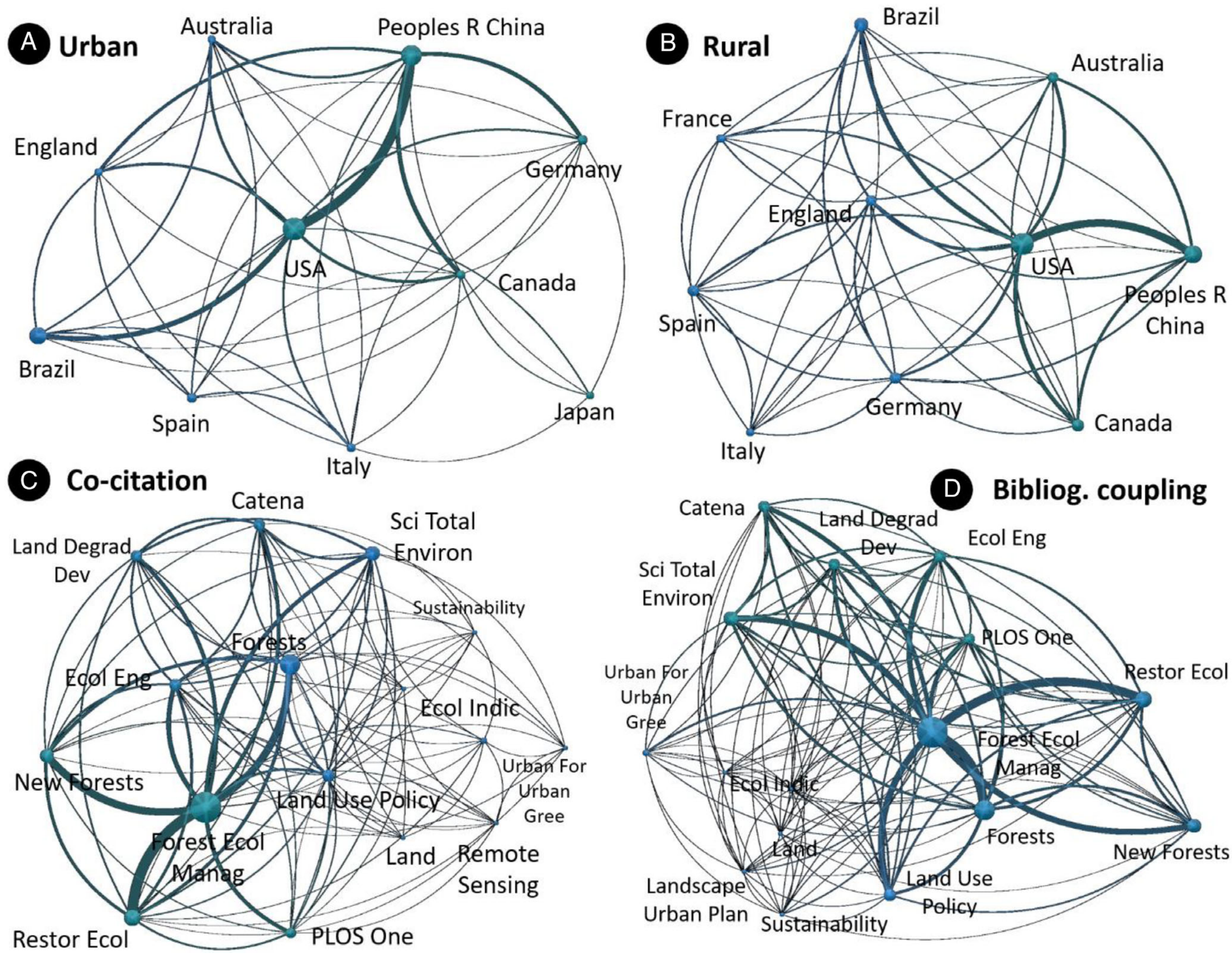

Fig. 4. Network analyses of co-authorship among the 10 most prominent countries publishing on urban (A) and rural (B) forest restoration, and citation analysis (C) and bibliographic coupling analysis (D) for the 15 most influential journals publishing urban or rural forest restoration research. The size of the node is proportional to the number of publications in each country or journal. The thickness of the line is proportional to the number of interactions between countries (A, B), of references they share (C), or the number of times they were cited together (D).

boundaries between two disciplines. We found that urban and rural forest restoration journals are often co-cited in individual publications (Fig. 4C); thus, they are jointly contributing to the development of both forest restoration fields.

Bibliographic coupling is a citation-analysis method that documents similarity – two papers are bibliographically coupled if they cite one or more references in common (Martyn, 1964; Romanelli *et al*., 2021*a*) and hence can indicate the intensity of knowledge sharing (Zhao & Strotmann, 2008). We found extensive bibliographic coupling, even for the more specialised urban forest restoration journals (Fig. 4D), indicating common research interests between the two fields. The strength of coupling can be expressed as the number of shared references between two journals (Martyn, 1964). The strongest bibliographic coupling network was between *Forests* and *Forest Ecology and Management* (N = 77,013), and between *Restoration Ecology* and *Forest Ecology and Management* (N = 70,726) (Fig. 4D). Below, we consider in more detail the fields of urban and rural forest restoration through the lens of the eight SER principles.

IV. EVIDENCE SYNTHESIS OF URBAN AND RURAL FOREST RESTORATION RESEARCH

(1) Stakeholder engagement: forest restoration should engage all key stakeholders

Urban forest restoration often is conducted by local government agencies (i.e. transportation, parks and recreation, etc.), commercial arboriculture firms, and non-profit organisations (Elmendorf, 2008; Schwab, 2009). Local stakeholders (e.g. residents and property owners) frequently become involved in the planting and care of urban trees and forests, especially as many cities have launched large-scale urban forestry programs (Pincetl, 2010), such as MillionTreesNYC (MTNYC) (MillionTreesNYC, 2010; Moskell *et al.*, 2010). The motivation of urban dwellers to engage in forest restoration projects can be shaped by emotional, aesthetic and spiritual values associated with trees and the landscape (Westphal, 1993). Trees are often symbols of cultural identity and connection to nature in various cultural contexts (Jones & Cloke, 2002). Urban residents' engagement may also be motivated by social reasons, such as community well-being, or interchange of experiences and knowledge (Hagger *et al.*, 2017; Jellinek *et al.*, 2019). Individuals derive a personal sense of stewardship and satisfaction from planting trees in their communities (Fisher, Svendsen & Connolly, 2015).

In rural settings, considering the scale at which international forest restoration pledges have been set, it is essential to consider stakeholders' engagement since multiple land users and rights-holders interact across the landscape. Many national governments have made commitments based on the forest landscape restoration (FLR) approach (Brancalion & Holl, 2020; Fagan *et al.*, 2020). The FLR approach explicitly differs from site-level forest restoration projects because it involves complex cross-scale and cross-level interactions that are affected by governance arrangements. Due to the involvement of diverse stakeholders in FLR programs, the use of participatory decision-making processes should ideally be intrinsic (Gold *et al.*, 2006; Brancalion *et al.*, 2016). Unfortunately, effective stakeholder engagement in FLR is typically absent, superficial or inappropriate (Murcia *et al.*, 2016; Höhl *et al.*, 2020; van Oosten, Runhaar & Arts, 2021). Top-down projects have often failed when they are not maintained and land can be repurposed by farmers over time for other uses (e.g. agriculture or livestock grazing), or when land tenure poses an issue (Chang & Andersson, 2021). Although less common, local residents themselves may hinder or halt forest restoration when they lack a sense of stewardship (Brancalion & Holl, 2020).

Both urban and rural forest restoration fields agree that stakeholder engagement is beneficial for achieving multiple goals, and long-term success. In rural landscapes, stakeholder engagement can go beyond national initiatives, while urban forest restoration often relies on local or regional stakeholder engagement, such as between neighbourhoods or cities. In rural settings, people living in or near restoration areas may have livelihoods that are dependent on forests, whereas urban forest restoration can elicit different values for city dwellers (e.g. recreational or aesthetic value). As each restoration project is unique in terms of stakeholders, engagement will often be context specific (Jellinek *et al.*, 2019; Fernandes *et al.*, 2022).

(2) Types of knowledge: forest restoration draws on many types of knowledge

Cities bring together dense and uniquely diverse sets of perspectives and knowledge types. In these conditions, sources of local ecological knowledge might include local residents with a range of interest levels in nature and even local nature associations (Yli-Pelkonen & Kohl, 2005). Environment professionals from both local governments and the private sector can also have granular insight into the ecology and seasonality of urban forests under their jurisdiction, and are closely aware of local constraints and demands on restoration practices. For instance, Sax, Manson & Nesbitt (2020) found that urban forest professionals in two large metropolitan areas put particular importance on urban forest accessibility (e.g. walking, public transport). Tapping into the expertise of these diverse groups can take a range of formats, from extended involvement in knowledge generation to highly formalised public hearings. One challenge of these methods is that they can selectively empower professionalised environmental NGO and municipal managers. Activities like local 'plan walks' (i.e. a participatory approach where stakeholders physically walk an urban area under consideration for either development or restoration) might be better adapted to the formation of common vocabularies and knowledge-sharing (Yli-Pelkonen & Kohl, 2005) but bring their own challenges (e.g. logistical issues, accessibility, and limited scope).

In rural landscapes, forest restoration is likely to impact different sets of stakeholders and land stewards, including farmers and Indigenous peoples. Knowledge from farmers, for example, will likely contribute to discussions on the selection of species for farming and land use planning (e.g. setting aside areas for conservation; Polyakov & Pannell, 2016). Indigenous peoples hold knowledge based on long experience with local ecosystems that are a source of their livelihood (Lévi-Strauss 1952; Schmidt *et al.*, 2021). Thus, traditional ecological knowledge (TEK) from rural communities is likely to be based on natural history knowledge, previous experience, market dynamics, emotional attachments to place, and care for wildlife (Wilmer *et al.*, 2020; Gornish *et al.*, 2021). TEK is site specific, based on adaptive learning (Chen *et al.*, 2016), and can be passed on through generations by cultural transmission (Berkes, Colding & Folke, 2000; Aswani & Hamilton, 2004; Bohensky, Butler & Davies, 2013). Indigenous knowledge can contribute to land productivity and biodiversity protection (Fischer *et al.*, 2008; Reyes-García *et al.*, 2019); but traditional practices may also sometimes contribute to ecosystem disservices, such as overgrazing or soil erosion (Hartel *et al.*, 2023).

While there may be established indigenous institutions in rural areas that can engage with restoration professionals (Wong *et al.*, 2020), the integration of indigenous perspectives into urban forest planning and restoration is still in its early stages (e.g. Frantzeskaki & Bush, 2021). Notably, many indigenous peoples now reside in urban centres, away from their ancestral lands and communities (e.g. Cardinal, 2006). Despite its recognised importance (Urzedo *et al.*, 2022), TEK is still an overlooked resource for both urban and rural forest restoration (Appendix S1).

(3) Target ecosystems: forest restoration can be informed by existing reference ecosystems together with conceptual trait-based approaches

In urban settings, the target ecosystems for guiding restoration are often existing urban forest fragments (i.e. remnants) rather than rural forests because city conditions are highly modified (Wallace & Clarkson, 2019). However, there are natural analogues for many of the severe environments found in urban and industrial settings (Lundholm & Richardson, 2010). Nonetheless, historic or pristine ecosystems have been reported to be potentially misleading templates for urban landscapes (Klaus & Kiehl, 2021), and there is often a paucity of detailed surveys or historic records for reliable restoration targets. Additionally, using contemporary forest fragments or historical records for target selection can limit the ability of cities to adapt to environmental change through ecosystem stewardship (Chapin *et al.*, 2010).

Some cities have initiated a process to articulate target ecosystem values that underpin restoration and management practices by setting functional goals (Natural Areas Conservancy, 2016; Santala *et al.*, 2022). Indeed, the prevailing paradigms for expanding and managing urban forests are those of landscape architecture and single-tree arboriculture, which are guided by aesthetics and objectives of shading and screening rather than any natural template (Nielsen & Jensen, 2007; Nassauer & Opdam, 2008). This functional approach to restoration allows for flexibility in species inclusion in the restoration palette and empowers 'functional substitutions'. For example, cases where non-native invasive species eliminate a first choice (e.g. Dutch elm disease *Ophiostoma* spp. or emerald ash borer *Agrilus planipennis* in the USA), a second species which fills the functional niche as closely as possible can be selected instead (Herms & McCullough, 2014; Muzika, 2017).

In urban woodlands, species composition, ecosystem properties, and the provision of desired ecosystem services can become uncoupled, making the use of a reference species composition an inappropriate measure. This is because a community of trees and shrubs found in a natural woodland remnant in an urban or industrial environment captures conditions that existed in the past (representing an 'extinction debt'), but ecosystem functions such as nutrient dynamics and decomposition rates have been drastically altered as urbanisation progressed (Cardou *et al.*, 2022).

In rural landscapes, forest restoration has long been undertaken for utilitarian reasons (e.g. fuelwood provisioning, erosion control, hydrological regulation), while goals of biodiversity protection are more recent (Burton & Macdonald, 2011; de Jong *et al.*, 2021). Such utilitarian and conservation objectives are integrated into international restoration commitments underpinned by the FLR approach. Hence, setting ambitious targets for restoration, and seeking FLR goals, would turn this approach into an end in and of itself (Stanturf & Mansourian, 2020). Selecting multiple and complex targets for large-scale forest restoration could be difficult because most landscapes contain many separate ecosystems, each with its own assemblage of species, and little may be known about many of these reference ecosystems. Furthermore, any large-scale forest restoration program is likely to involve a variety of approaches (see Section IV.8) because of the diversity of environmental conditions and landholder aspirations (Stanturf *et al.*, 2014). The alternative of choosing less-ambitious targets when resources and budgets are scarce, or when continuous management cannot be ensured, may result in fewer ecological benefits but may be the most pragmatic option (Ehrenfeld, 2000; Van Diggelen, Grootjans & Harris, 2001). Finally, addressing climate change appears to be a focus in rural forest restoration, where future climate analogues are being used in the sourcing of plant materials, and in the anticipation of alternative silvicultural approaches (Harrison *et al.*, 2017; Mette, Brandl & Kölling, 2021; Nagel *et al.*, 2017). Effects of climate change are compounding the numerous current pressures on urban forest restoration success, suggesting that future climates will not support historic species assemblages. Therefore, selection of species for urban restoration should focus on those adapted to thrive under future scenarios (Hammes *et al.*, 2020).

While there are similarities in considerations for target selection in both urban and rural contexts, such as composition, structure, and functional components, there are also differences. Urban targets can require engineering to meet specific ecosystem service priorities and management needs. They also need to address small patch size and poor landscape connectivity. Genetic diversity is important in both fields to enhance climate-change resilience. Ideally, a mixed approach that considers past and contemporary reference sites, along with future climate change scenarios, should be employed to set targets along the urban–rural continuum to maximise restoration outcomes.

(4) Ecosystem recovery process: forest restoration supports ecosystem recovery

In urban sites, the ability to rely on ecosystem recovery processes is impacted by multiple factors commonly associated with human-dominated landscapes (Piana *et al.*, 2019; Johnson *et al.*, 2021). Restoration of urban forests often relies on planting, which may have the potential to promote native plant diversity and structural complexity (e.g. Johnson & Handel, 2016). Long-term studies have begun to provide a better understanding of alternative planting strategies, such as controlling initial species composition and functional diversity (Robinson & Handel, 2000; Oldfield *et al.*, 2015), broadcast seeding and enrichment plantings (Laughlin & Clarkson, 2018), canopy manipulations (Pastick, Maurer & Fahey, 2021), and the potential for natural regeneration (Wallace, Laughlin & Clarkson, 2017; Piana *et al.*, 2021*a*). Collectively, these approaches are improving understanding of forest recovery potential, management regimes and timeframes for restoration (e.g. Simmons *et al.*, 2016; Johnson & Handel, 2019), and are developing approaches that can minimise management inputs while supporting project success.

In rural landscapes, natural regeneration emerges as a pivotal strategy for large-scale forest restoration (Fig. 1). This approach thrives under favourable conditions, capitalising on recruitment mechanisms such as seed dispersal or seed banking (Ashton & Kelty, 2018; Piana *et al.*, 2021*a*), which play a crucial role in the overall recovery process. Proximity to seed sources within remaining forest patches also contributes to the acceleration of forest regeneration (Thomlinson *et al.*, 1996; Toriola, Chareyre & Buttler, 1998), particularly the recruitment of species characteristic of natural forest (Chazdon, 2003). In addition, focusing on natural regeneration in rural landscapes also underlines the need to restore forests in the right place, that is, where forests naturally grow, instead of reconditioning tree planting in locations where disturbance regimes favour herbaceous vegetation over woody species (Fig. 1) (Rédei *et al.*, 2020). Alternatively, mixed-species restoration plantings have been broadly used to restore forests in lower resilience areas and have achieved high levels of recovery, especially across the tropics, despite higher costs and ecological limitations (Rodrigues *et al.*, 2011; Crouzeilles *et al.*, 2017). Since such plantings are based on the initial establishment of a diverse – yet incomplete – set of native trees to recover forest structure in a converted area, the success of these restoration plantings is also dependent upon the recovery of ecological processes, especially those that are mediated by animals and non-tree life forms that are not introduced by people (Garcia *et al.*, 2016).

The focus of urban forest restoration is often on planting and management rather than promoting natural regeneration (Piana *et al.*, 2021*a*,*b*), whereas rural forest restoration relies on natural regeneration to restore large areas. Research has shown that urban forests have higher non-native seedling species richness (Guntenspergen & Levenson, 1997; Zipperer, 2003; Cadenasso, Pickett & Schwarz, 2007) and reduced native seedling abundance compared to rural forests (Trammell & Carreiro, 2011; Wallace *et al.*, 2017). Passive methods used at scale in rural sites have not been well tested in urban areas. Factors such as patch size, connectivity, and land use conflicts can differ between urban and rural areas, requiring context-specific approaches for restoration.

(5) Goals, objectives, and indicators: assessment of forest restoration success against clear goals and objectives using measurable indicators

Urban forest restoration is increasingly used as a measure to improve the delivery of specific ecosystem services such as improvement of air quality, amelioration of urban heat island effects, improved stormwater infiltration, and provision of social outcomes like better human physical and mental health (Johnson & Handel, 2016; Xie, Lu & Zheng, 2022). These human-centric goals shape restoration planning and subsequently the type of indicators necessary to measure success. Successful urban forest restoration incorporates a clear understanding of the varied goals of urban dwellers, and how different motivations can be integrated optimally to balance different outcomes. This represents a research frontier in urban forest restoration (Jellinek *et al.*, 2019).

In rural settings, there is a long history of farmer-driven forest restoration (Djenontin, Ligmann-Zielinska & Zulu, 2022) and a relatively good understanding of the motivations for this activity. As goals of rural forest restoration, recent global (Höhl *et al.*, 2020) and national (Hagger *et al.*, 2017) surveys involving different restoration practitioners have reported biodiversity enhancement and ecosystem recovery (Section IV.4) as some of the main motivations for undertaking restoration projects (i.e. biotic and pragmatic motivations). Survey respondents (e.g. local communities) have listed protection functions (e.g. erosion), water issues, nature and biodiversity conservation, forest productivity, and income generation as important secondary goals (Hagger *et al.*, 2017; Höhl *et al.*, 2020). Occasionally, a mismatch between global goals and local restoration management has been reported (Höhl *et al.*, 2020). Misconceptions can be far-reaching. For example, in attempts to increase global forest cover, if savanna, a natural grassland biome, is misinterpreted by local restoration management as a degraded forest ecosystem it may be inappropriately subjected to forest restoration activities (Meyer & Pebesma, 2022; Kumar *et al.*, 2020).

By identifying and prioritising shared goals and objectives in urban and rural forest restoration, a unified framework can be fostered, harnessing the distinctive strengths and considerations of each context. Regular review and adaptation, driven by feedback, monitoring results, and emerging knowledge, are vital to maintaining the framework's relevance and alignment with evolving restoration needs and priorities.

(6) Achieving a high level of recovery: pursing the highest level of forest recovery possible

Cities are conducting forest restoration projects to support a range of ecosystem services (Nowak, 2012; Brancalion *et al.*, 2014) due to the increasingly recognised benefits of urban tree canopies (Nowak *et al.*, 2001; McPherson *et al.*, 2005; Roy, Byrne & Pickering, 2012). The highly transformed nature of urban regions, however, prevents biodiversity recovery that resembles natural baselines, and local biota is often composed of generalist, disturbance-adapted species. Urban restoration research has primarily focused on the recovery of plant community diversity and structure, with long-term studies observing greater native plant diversity and structural complexity in forest restoration sites than in unrestored sites (Johnson & Handel, 2016). Manipulative studies comparing management strategies highlight the positive impact of sustained restoration interventions, including invasive plant control or enrichment plantings on forest diversity and structure (e.g. Laughlin & Clarkson, 2018; Johnson & Handel, 2019), ecosystem functioning (e.g. Wallace *et al.*, 2018) and landscape management regime (e.g. Himes *et al.*, 2022). In highly disturbed landscapes, afforestation studies demonstrate that the diversity of planting assemblages and the addition of structural diversity (e.g. planting shrubs) can improve forest recovery including native plant recruitment and soil processes (Oldfield *et al.*, 2015; Ward *et al.*, 2021; Mejía *et al.*, 2022; Robinson & Handel, 2000; Doroski *et al.*, 2018). If we expand the definition of recovery to the context of street trees, then we would expect recovery to refer to tree survival, anticipated growth with minimal inputs, and effective provision of desired ecosystem services. Activities that genuinely aim to mitigate or attain a net reduction in human impacts (and thus improve the potential for ecosystem recovery) can therefore be considered allied to ecological restoration and part of the restorative continuum (Section IV.8) (Gann *et al*., 2019).

In rural landscapes, high levels of recovery have been documented for active forest restoration projects and natural regeneration at the local or plot level, particularly in tropical forests. For example, natural regeneration in Neotropical secondary forests can result in a nearly 80% recovery of aboveground biomass and soil functions within 20 years (Rozendaal *et al*., 2019). However, in the same sites, tree diversity and composition was estimated to require several decades to centuries to recover (Rozendaal *et al*., 2019). Full recovery is still rarely documented and recent intense environmental changes could prevent many ecosystems from achieving pre-disturbance or reference ecosystem levels of diversity, structure, and functioning. At the landscape scale, however, restoring forests cost-effectively, with social justice and the pursuit of a high level of recovery, also remains a challenge (Churchill *et al*., 2013; Molin *et al*., 2018; Gastauer *et al*., 2021).

Achieving high levels of recovery in both urban and rural landscapes is challenging and may take considerable time. Biophysical and socio-economic constraints can limit the potential for full recovery to reference conditions, but utilitarian objectives can still be achieved and may represent a way to improve outcomes in a larger forest restoration framework. The native forest reference approach (Section IV.3) enables multiple outcomes to be delivered simultaneously (Oldfield *et al*., 2015). Yet, in heavily degraded and altered sites such as cities, an approach of 'designed ecosystems' may be more appropriate than ecological restoration. As such, tailored strategies to achieve high levels of recovery also need to be considered. Too often, both urban and rural restoration research focuses on plant community structure or diversity, without assessing other aspects of functional and ecosystem recovery (Montoya, Rogers & Memmott, 2012; Brudvig, 2011). Long-term studies, especially in urban areas, are also scarce, and there is limited knowledge of ecosystem function recovery in restoration sites. Recent studies are emerging on urban restoration methods, including passive restoration and natural regeneration (Piana *et al*., 2021*a*), but there is a lack of robust understanding of baseline function in urban forest systems. Whether urban forest restoration sites diverge in function (ability to self-sustain) from rural forests is also an unanswered question.

(7) Cumulative ecological outcomes: forest restoration gains cumulative value when applied at large scales

While urban landscapes provide considerably less space for restoration than rural landscapes, large-scale projects have been increasingly deployed in cities (Yao *et al*., 2019). Examples include green belt formations in Paris, France (2662 km^2) (Amati, 2016; Roussel *et al*., 2017), London, UK (Mersey Community Forest, 1370 km^2) (The Mersey Forest Offices, 2014), and Moscow, Russia (1625 km^2) (Boentje & Blinnikov, 2007). These programs vary in their structure, objectives, and organisation (Yao *et al*., 2019). In contrast to large areas, there is a growing trend toward small forest patches on vacant lots, some using the mini-forest methods of Miyawaki (1998). Urban environments are quite heterogeneous and urban forests are scattered and frequently disturbed in comparison to native forests (Cadenasso *et al*., 2007). As such, seeking improved ecological outcomes in the urban matrix will require a landscape-scale lens that views both small and large forest patches in their broader context (Johnson & Handel, 2016). Small fragments of remnant or regenerating forests within cities represent important reservoirs of local biodiversity and sources of valuable ecological functions (Ehrenfeld, 2000; Johnson & Handel, 2016), yet their isolation typically limits landscape connectivity (i.e. species movement and flow) (Holl, Crone & Schultz, 2003; Hogan *et al*., 2012). Thus, connecting large- and small-scale forest restoration projects within cities is essential to improving ecological outcomes (e.g. species diversity) in the urban landscape (Saura, Bodin & Fortin, 2014; de la Fuente *et al*., 2018). Riparian corridors, green spaces, stepping stones, and permeable matrices have been reported as effective alternatives to increase landscape connectivity (de la Fuente *et al*., 2018; Huang *et al*., 2018), supporting species permanence and dispersion (Boulton, Dedekorkut-Howes & Byrne, 2018; Huang *et al*., 2021).

In rural landscapes, space and timeframes of forest restoration are crucial to achieving ecological processes that operate at the landscape level (Holl *et al*., 2003); for example, trophic chains, colonisation, and predation (Hogan *et al*., 2012; Gann *et al*., 2019). Large-scale projects are expected to improve landscape connectivity (e.g. wildlife corridors) (Fig. 1) and lead to different expectations for species diversity within restoration patches (Damschen *et al*., 2019; Brudvig & Catano, 2021), and also mitigate biotic homogenisation (Menz, Dixon & Hobbs, 2013). Water security (in terms of quality, quantity, and flows) is also most effectively achieved by working at the landscape, watershed scale and linking terrestrial and aquatic systems (Locatelli *et al*., 2015; Chazdon & Uriarte, 2016). Ecosystem process-based research and management is valuable for this purpose (Beechie & Bolton, 1999). Many species that have been restricted to small areas of intact forest often benefit from expanding forest cover and connectivity (Chazdon & Uriarte, 2016). Yet, it is important for large-scale forest restoration to result in net-positive landscape change. Nevertheless, prioritising different restoration objectives can result in different spatial configurations and trade-offs among ecosystem services (e.g. Barnett, Fargione & Smith, 2016).

The scale of restoration projects has a significant impact on ecological outcomes in both rural and urban landscapes. Small urban forest restoration projects are important for local biodiversity and landscape stabilisation but often fall short of their ecological potential due to size, edge effects, and lack of connectivity. Thus, building an urban ecological network that connects peri-urban and rural areas poses a challenge for urban planners. In rural landscapes, integrating local restoration projects strategically within larger restoration programs that involve multiple activities across the landscape can improve ecological outcomes. Water bodies play a critical role as connectors and integrators of material and energy flows, making adjacent terrestrial ecosystems important targets for restoration. Forest restoration management in the rural–urban interface can provide multiple benefits, including wildfire risk reduction, improved drought and insect pest resistance, biodiversity habitat, and recreational opportunities, although trade-offs between fuel reduction needs and adherence to reference ecosystems may arise (Vogler *et al.*, 2015; Stephens *et al.*, 2021).

(8) Continuum of restorative activities: forest restoration as part of a continuum of restorative activities

Cities are, by definition, ecosystems that have been deeply modified to accommodate high densities of people. Restorative activities in cities span the gamut from reducing or mitigating ongoing pressures on ecosystems, to rehabilitating ecosystem function and native species. Most actions aimed at reducing impact fall under the management responsibilities of urban foresters. For instance, managers routinely seek to reduce immediate harm to urban woodlands by formalising or fencing footpaths to reduce informal use. Other actions also include regulating use depending on vehicle weight and type (e.g. mountain bikes) or closing off paths seasonally to reduce damage at key times of the year. More generally, activities viewed as restoration in cities typically focus on restoring specific ecosystem functions or biodiversity aspects through site rehabilitation (Klaus & Kiehl, 2021), and kick-starting woodland self-regeneration. This often includes dense plantings of native species over small areas, for instance, to control soil erosion and restore water retention capacity (https://cities4forests.com/).

In rural settings, forest restoration projects or programs often cover more than one category of restorative activities across the continuum, particularly those carried out within larger frameworks, such as FLR (Mansourian, Vallauri & Dudley, 2005; Sabogal, Besacier & McGuire, 2015). FLR may include different types of restorative activities as they are applied to different ecosystems within a landscape (Maginnis & Jackson, 2005). Although the focus of FLR is human well-being, effective FLR projects are based on a balance between natural and productive systems (Coppus *et al.*, 2019); where a suite of different land uses, varying from natural forest cover to commercial plantations, natural and assisted regeneration, and agroforestry and silvopastoral systems, coexist within a 'multifunctional landscape' (Maginnis & Jackson, 2005; Aronson, Blignaut & Aronson, 2017). Thus, forest restoration activities in rural landscapes are often based on a combination of historical, ecological, and socio-economic factors at different spatial scales (Di Sacco *et al.*, 2021).

Rural forest restoration often incorporates larger areas and limited resources, requiring careful allocation to achieve desired outcomes across a wide expanse. Conversely, urban restoration often focuses on smaller areas, leading to greater resource allocation per unit area, due to the need for specialised management approaches and interventions. As such, finding a balance between cost-effectiveness and ecological effectiveness that suit both contexts is crucial to advance an integrated framework for forest restoration that optimises resource allocation and maximises the benefits of restoration across the urban–rural continuum (Pregitzer *et al.*, 2018; Noulèkoun *et al.*, 2021).

V. CAVEATS

The broad spectrum of silvicultural practices often closely aligns with the comprehensive definition of restoration, particularly in rural areas and following significant, unprecedented disruptions like intense fires or severe droughts. The crux of the urban silviculture concept lies in cities, where restoration holds a dominant perspective and silviculture can seamlessly integrate to inform practice. Consequently, we emphasise the potential for shared knowledge and reciprocal learning between these two disciplines (Fahey *et al.*, 2018; Achim *et al.*, 2022).

Based on historical knowledge, recent scientific studies, and stakeholders' expertise, this narrative synthesis attempts to provide a sound overview of the literature in which aspects of urban and rural forest restoration are both discussed. As such, our aim was not to provide a systematic overview of the literature but to undertake a synthesis of convergent and divergent aspects in the sibling fields of urban and rural forest restoration, seeking to advance both fields. By selectively including studies and shaping discussions in narrative reviews, authors may not be able to identify all important aspects of the available evidence, such as potential conflicting results among primary studies (Ladhani & Williams, 1998; Romanelli *et al.*, 2020). Our objective herein was to use our experience to discuss forest restoration based on the eight Principles, and engaging key stakeholders and experts on each topic addressed. Since 'bias' (i.e. creative selection and combination) is a major concern for narrative reviews, we echo the view of Dijkers (2009) that readers benefit when review authors make explicit their preferences, values, and scope of the synthesis. Based on previous research (Dijkers, 2009; Romanelli *et al.*, 2021*a*), we also argue that a narrative synthesis can effectively serve important purposes (e.g. informing research decision-making and science) when authors transparently report the external validity of outcomes and highlight potential limitations, so readers can interpret the findings in this light.

VI. CONCLUSIONS

(1) There is a growing opportunity for forest restoration research and practical applications to span the urban–rural continuum. This expansion enables the support of restoration strategies that effectively tackle the complexities posed by various human-caused disruptions and a wide range of disturbance intensities. In fact, recent research has supported cities as surrogates for future climatic conditions in non-urban ecosystems (Zhao, Liu & Zhou, 2016; Lahr, Dunn & Frank, 2018).

(2) To integrate urban–rural forest restoration effectively within a broader framework, it is crucial to adopt a comprehensive view of forests that encompasses both contexts. This entails recognising the complexities and opportunities specific to each setting. A more comprehensive scope for forest restoration will also require the implementation of context-specific restoration strategies and the formulation of integrative policies that support larger-scale programs.

(3) Our analysis of the literature revealed shared research interests and knowledge exchange between urban and rural forest restoration fields. This indicates a trend within the academic community towards integrating these disciplines. Evidence of this integration can be observed in the parallel development of research topics outlined by the eight SER principles. Authors from both fields actively foster collaborative networks in their scientific endeavours, which not only facilitate research integration but also promote the transfer of knowledge.

(4) Our synthesis of the literature revealed divergences in terms of project scale, stakeholders, resource allocation, and management approaches between urban and rural forest restoration, but there are also common interests. For example, stakeholder engagement, incorporating Indigenous perspectives and traditional ecological knowledge, and setting appropriate targets are key considerations. For a more integrative forest restoration framework, building ecological networks and integrating local projects within larger programs could enhance ecological outcomes. Regular monitoring, adaptation, and a unified framework based on shared goals are essential for long-term success. By finding a balance between cost-effectiveness and ecological effectiveness, and considering the unique characteristics of each landscape, an integrated framework could maximise the benefits of forest restoration across the urban–rural continuum.

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IX. SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Search strategies and data analysis.
Fig. S1. Research trends on urban and rural forest restoration from the *Web of Science* platform.

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