Connected but Misaligned: Rethinking Urban Nature for Biodiversity, Equity, and Resilience

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Highlights

- Connected urban nature can still fail if key systems are misaligned.
- Effective planning aligns biodiversity, benefits, access, and governance.
- Misalignment appears as missing connections or harmful flows.
- Alignment audits can reveal benefit gaps, unsafe access, risk transfer, and weak accountability.
- The framework helps decide when to connect, redesign, buffer, or selectively disconnect.

Abstract

Urban nature is often planned through partial forms of connectivity: habitat corridors for biodiversity, green infrastructure networks for ecosystem services, accessibility networks for public use, and governance networks for implementation. Yet connected urban nature can still fail. Connectivity misalignment occurs when connections in one domain coexist with disconnection, inequity, risk, weak monitoring, or weak governance in another. This Perspective proposes connectivity alignment as a diagnostic and planning framework for urban nature. The framework evaluates ecological, benefit-flow, socio-cultural, and governance connectivity through equity, scale, and safety-risk lenses. It identifies two recurring forms of misalignment: incomplete connectivity, where necessary connections are absent, weak, uneven, or mismatched; and harmful connectivity, where connections transmit risk, disturbance, exclusion, or burden. The paper then introduces alignment audits as a practical process for diagnosing misalignment and guiding planning responses, including connection, realignment, buffering, redesign, filtering, monitoring, coordination, funding, accountability, and selective disconnection.

Keywords: urban green infrastructure; urban ecological networks; connectivity alignment; ecosystem-service flows; environmental justice

1. Introduction: The problem of connectivity misalignment

Cities are increasingly investing in connected urban nature through ecological corridors, blue-green infrastructure, park networks, riparian restorations, street-tree corridors, and nature-based solutions. These investments are often designed to address biodiversity loss, climate risk, public health inequity, and fragmented urban landscapes (Andersson et al., 2022; Childers et al., 2019; Hilty et al., 2020; Kabisch et al., 2022; LaPoint et al., 2015; Zúñiga-Terán et al., 2020). This growing interest in connectivity reflects an important insight. Urban nature works through relationships among habitats, species movement, hydrological flows, cooling effects, social access, cultural meaning, infrastructure, institutions, and maintenance systems (Hardy et al., 2022; McPhearson et al., 2022).

Yet connected urban nature can still fail. A greenway may provide recreational continuity and offer limited habitat value (Hilty et al., 2020; LaPoint et al., 2015; Nilon et al., 2017). A biodiversity corridor may improve species movement and remain unsafe or inaccessible for nearby residents (Abdulla et al., 2025; Hilty et al., 2020; Rigolon et al., 2021). A tree-canopy network may cool some districts and leave historically disinvested neighborhoods with higher heat exposure (Grove et al., 2015; Locke et al., 2021; Schwarz et al., 2015; Ziter et al., 2019). A flood-management system may reduce runoff in one jurisdiction and leave downstream exposure unresolved (Barnett & O'Neill, 2010; Bergsten et al., 2014; McGlynn et al., 2023). A governance network may increase coordination among agencies and leave authority, funding, maintenance, monitoring, or accountability unclear (Bodin, 2017; Kabisch et al., 2022; Keeley et al., 2022; McGlynn et al., 2023; Toxopeus & Polzin, 2021).

These examples point to a central problem in urban nature planning: connectivity is often partial. Landscape ecology emphasizes habitat continuity, movement pathways, dispersal, and barrier reduction (Hilty et al., 2020; LaPoint et al., 2015). Green infrastructure planning emphasizes linked networks for stormwater management, cooling, recreation, and resilience (Andersson et al., 2022; Childers et al., 2019; Zúñiga-Terán et al., 2020). Ecosystem-service frameworks examine how benefits are supplied, transported, and received (Cortinovis & Geneletti, 2019; Mitchell et al., 2015). Accessibility research evaluates whether people can reach, use, feel safe in, and benefit from green spaces (Abdulla et al., 2025; Rigolon et al., 2021; WHO Regional Office for Europe, 2017). Governance research examines institutional coordination, actor networks, social-ecological fit, information systems, monitoring responsibilities, and accountability mechanisms (Bergsten et al., 2014; Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023).

Each approach contributes necessary insight. Taken separately, these approaches can produce incomplete diagnoses. Urban nature may be connected in one domain and remain disconnected, inequitable, risky, poorly monitored, or poorly governed in another. This matters because urban nature is increasingly expected to support biodiversity, equity, and resilience together (Kabisch et al., 2022; McPhearson et al., 2022; Nilon et al., 2017). A system can support biodiversity in selected habitats, provide access for selected users, or reduce selected hazards, yet remain poorly aligned with the urban landscape.

This Perspective argues for connectivity alignment as a diagnostic and planning framework. Connectivity alignment refers to the condition in which ecological, benefit-flow, socio-cultural, and governance connections reinforce one another across relevant scales and avoid preventable harm. The framework's contribution lies in diagnosing how established connectivity dimensions interact within urban nature interventions and translating that diagnosis into planning responses.

The paper makes three contributions. First, it defines connectivity misalignment as a planning problem that explains why connected urban nature can fail to produce cohesive biodiversity, equity, and resilience outcomes. Second, it proposes a diagnostic framework for evaluating whether four forms of connectivity are mutually reinforcing, incomplete, or harmful. Third, it introduces alignment audits as a practical way to apply the framework.

2. Existing approaches and the need for an alignment lens

Urban connectivity research provides a strong foundation for this framework (Hardy et al., 2022; LaPoint et al., 2015). Ecological connectivity research shows that biodiversity persistence often depends on the movement of organisms, genes, propagules, materials, and ecological processes across fragmented landscapes (Hilty et al., 2020; LaPoint et al., 2015). Corridors, stepping stones, permeable matrices, and habitat networks can support species movement and adaptation in urban regions (Hilty et al., 2020; LaPoint et al., 2015). These priorities vary by species, dispersal capacity, and ecological process (Hilty et al., 2020; Molné et al., 2023; Préau et al., 2022).

Green infrastructure and hybrid infrastructure frameworks extend connectivity thinking to ecosystem services and infrastructure performance. They frame urban nature as part of a connected system for stormwater management, cooling, recreation, health, and resilience (Andersson et al., 2022; Browder et al., 2019; Childers et al., 2019; Zúñiga-Terán et al., 2020). Ecosystem-service capacity-flow-demand frameworks clarify how benefits are produced, move across landscapes, and reach beneficiaries (Cortinovis & Geneletti, 2019; Mitchell et al., 2015).

Eco-social and social-ecological connectivity research widens the lens. It emphasizes relationships among people, green spaces, ecosystem services, stewardship, biological mechanisms, and social landscape features (Butler et al., 2022; Egerer & Anderson, 2020; Egerer et al., 2020). Accessibility research shows that proximity alone provides an incomplete account of meaningful access. Physical distance, perceived safety, cultural fit, emotional comfort, quality, maintenance, and inclusion all shape whether people benefit from urban green space (Abdulla et al., 2025; Rigolon et al., 2021; WHO Regional Office for Europe, 2017).

Governance and institutional-fit frameworks show that connectivity depends on both institutional and spatial design. It depends on coordination among agencies, jurisdictions, funding streams, maintenance responsibilities, actor networks, legal authority, data systems, monitoring arrangements, and accountability mechanisms (Bergsten et al., 2014; Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023). Social-ecological-technological systems integration further shows how urban ecosystem services and nature-based solutions emerge from interactions among social, ecological, built, infrastructural, and governance systems (McPhearson et al., 2022).

These approaches provide many of the concepts and methods needed for connectivity-oriented urban nature planning. The remaining gap is a compact diagnostic framework that evaluates how these forms of connectivity interact within specific urban nature interventions.

Table 1. Existing approaches and what a connectivity-alignment lens adds

Framework or approach	**Main contribution**	**Remaining diagnostic gap**	**What connectivity alignment adds**
Ecological connectivity and corridor planning	Identifies habitat links, corridors, stepping stones, barriers, movement pathways, and ecological-process flows (Hilty et al., 2020; LaPoint et al., 2015; Molné et al., 2023).	Urban benefit distribution, lived access, environmental justice, governance accountability, and cross-domain trade-offs can remain outside the primary diagnosis.	Tests whether biodiversity connectivity aligns with benefit-flow, socio-cultural, governance, equity, and safety-risk conditions.
Urban green infrastructure and hybrid infrastructure	Frames green, blue, and gray systems as infrastructure for stormwater management, cooling, recreation, health, resilience, and multifunctional performance (Andersson et al., 2022; Browder et al., 2019; Childers et al., 2019; Zúñiga-Terán et al., 2020).	Biodiversity quality, lived experience, displacement risk, maintenance responsibility, and trade-offs among services can receive uneven attention.	Evaluates whether service-oriented networks also support ecological quality, meaningful access, equitable benefit distribution, risk safeguards, and long-term governance.
Ecosystem-service capacity-flow-demand frameworks	Examines how ecosystem-service capacity, supply, demand, flows, and benefits are shaped by landscape structure and population distribution (Cortinovis & Geneletti, 2019; Mitchell et al., 2015).	Cultural meaning, stewardship, emotional access, governance accountability, and conflict among ecological, social, and institutional objectives can remain less developed.	Connects benefit delivery to ecological processes, socio-cultural access, governance responsibility, scale fit, and risk transfer.
Connectivity Benefits Framework	Links habitat, geophysical, and eco-social connectivity to urban livability, benefits, risks, management actions, and valuation (Hardy et al., 2022).	This is the closest existing framework to the present argument. It gives less emphasis to cross-domain alignment, governance connectivity as a full domain, alignment audits, and selective disconnection.	Reframes connectivity as an alignment problem and links diagnosis to planning responses across four domains and three lenses.
Eco-social and social-	Links people, green spaces, stewardship, ecosystem services, biological	Biodiversity outcomes, governance accountability, risk-sensitive design, and	Tests whether people-nature relationships align with habitat

ecological connectivity	mechanisms, and social landscape features (Butler et al., 2022; Egerer & Anderson, 2020; Egerer et al., 2020).	planning responses across multiple domains can remain less explicit.	quality, benefit delivery, institutional capacity, and risk safeguards.
Urban green space accessibility frameworks	Evaluates whether people can reach, use, feel safe in, feel welcome in, and benefit from urban green spaces (Abdulla et al., 2025; Rigolon et al., 2021; WHO Regional Office for Europe, 2017).	Physical proximity can overshadow quality, safety, cultural fit, emotional comfort, ecological function, and maintenance.	Distinguishes physical access from meaningful socio-cultural connectivity and links access to ecological, benefit-flow, and governance outcomes.
Social-ecological fit and governance networks	Examines whether institutions, actors, jurisdictions, land management systems, and governance networks align with ecological and social processes (Bergsten et al., 2014; Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023).	Design-facing diagnostics for comparing ecological, benefit-flow, socio-cultural, and governance connectivity can remain underdeveloped.	Treats governance connectivity as a core domain, including authority, funding, maintenance, information sharing, monitoring, participation, and accountability.
Ecosystem disservices and harmful connectivity	Shows that urban ecological networks and green infrastructure can produce or transmit ecosystem disservices, disturbance, exposure, and unwanted risks (Hashemi & Darabi, 2026; von Döhren & Haase, 2022).	Risks are often treated as cautions added after connectivity goals have already been established.	Makes safety-risk a core lens and treats buffering, controlled permeability, redesign, and selective disconnection as legitimate planning responses.

Table 1 shows that existing approaches are powerful and partial in different ways. Connectivity alignment addresses this gap by asking whether the right forms of connectivity are present for the right species, services, communities, institutions, information systems, and timescales. Connectivity misalignment is the diagnostic problem. Connectivity alignment is the planning response.

3. Defining connectivity alignment

Connectivity is often treated as a planning good. More corridors, stronger networks, increased access, and greater institutional coordination are commonly assumed to produce better urban nature systems (Hilty et al., 2020; Kabisch et al., 2022; Zúñiga-Terán et al., 2020). This assumption is incomplete. Connectivity can transmit benefits and also harm (Hardy et al., 2022; Hashemi & Darabi, 2026). It can support resilience and shift vulnerability elsewhere (Barnett & O'Neill, 2010; Meerow et al., 2016). It can improve access and increase disturbance, exclusion, or displacement pressure when safeguards are weak (Abdulla et al., 2025; Anguelovski et al., 2019; Marion et al., 2020; Wolch et al., 2014).

The central planning issue is whether urban nature connections are aligned. Connectivity alignment occurs when ecological, benefit-flow, socio-cultural, and governance connections reinforce one another across relevant scales and avoid preventable harm. Connectivity misalignment occurs when these connections are absent, weak, mismatched, inequitable, risky, weakly monitored, or weakly governed.

Two forms of misalignment are especially important.

Incomplete connectivity occurs when a necessary connection is absent, weak, poorly distributed, or poorly matched to the problem it is meant to address. A high-quality habitat patch may be isolated from other habitats. A park may be near a heat-vulnerable community and lack safe walking routes, welcoming entrances, or maintenance. A citywide tree canopy plan may increase total canopy but fail to cool the most exposed streets. A flood project may follow municipal boundaries even as flood processes follow watersheds. Incomplete connectivity includes missing links and cross-domain mismatches, where the four domains operate at different scales, serve different groups, or fail to reinforce one another.

Harmful connectivity occurs when connected systems transmit risk, disturbance, exclusion, displacement pressure, ecosystem disservices, or other burdens. Ecological corridors may facilitate the spread of invasive species, pests, pathogens, or unwanted ecological flows (Hashemi & Darabi, 2026; von Döhren & Haase, 2022). Increased access may disturb sensitive habitats or wildlife behavior (Marion et al., 2020). Blue-green infrastructure may reduce risk in one place and leave downstream communities exposed when watershed processes and governance responsibilities are misaligned (Bergsten et al., 2014; McGlynn et al., 2023). Green amenities may contribute to displacement pressure when greening lacks housing and anti-displacement safeguards (Anguelovski et al., 2019; Wolch et al., 2014). In these cases, the appropriate response may be buffering, filtering, controlled permeability, redesign, or selective disconnection.

This framing changes connectivity from a broad aspiration into a diagnostic question. Which connections are needed? Which are missing or mismatched? Which transmit harm? Which should be strengthened, realigned, buffered, redesigned, governed more carefully, monitored, or selectively disconnected?

4. A connectivity alignment framework for urban nature

The proposed framework includes four domains: ecological connectivity, benefit-flow connectivity, socio-cultural connectivity, and governance connectivity. These domains are evaluated through three cross-cutting lenses: equity, scale, and safety-risk. The framework is a heuristic for diagnosis and planning. It structures planning judgment while leaving room for domain-specific ecological, hydrological, social, and governance analysis.

The framework uses the terms biodiverse, equitable, and resilient in specific ways. Biodiverse urban nature supports habitat quality, species movement, population persistence, ecological interactions, and ecosystem processes (Knapp et al., 2021; Nilon et al., 2017). Equitable urban nature distributes benefits, access, participation, safety, and burdens fairly, especially for historically underserved communities (Rigolon et al., 2021; Schlosberg, 2007; Wolch et al., 2014). Resilient urban nature can absorb, buffer, adapt to, or recover from disturbance while reducing the transfer of risk to more vulnerable places or groups (Barnett & O'Neill, 2010; Meerow et al., 2016).

4.1 Ecological connectivity

Ecological connectivity concerns the movement of organisms, genes, propagules, materials, and ecological processes across urban landscapes (Hilty et al., 2020; LaPoint et al., 2015). It is assessed through habitat patches, species populations, ecological flows, dispersal pathways, disturbance regimes, and landscape matrices.

Ecological connectivity concerns whether urban landscapes support the persistence of biodiversity across space and time. It examines corridors, stepping stones, barriers, habitat permeability, seasonal habitat use, matrix quality, edge effects, and life-stage requirements (Hilty et al., 2020; LaPoint et al., 2015; Molné et al., 2023). Connectivity needs differ across species and systems (Hilty et al., 2020; Préau et al., 2022). A corridor that supports birds may offer limited value for amphibians. A tree-lined street may contribute to canopy continuity and provide weak habitat quality for specialist species. For planning, ecological connectivity requires attention to species-specific movement, habitat quality, disturbance sensitivity, ecological traps, temporal dynamics, and cross-scale habitat networks.

4.2 Benefit-flow connectivity

Benefit-flow connectivity concerns the production, movement, and distribution of ecosystem-service benefits across urban systems (Cortinovis & Geneletti, 2019; Mitchell et al., 2015). It is assessed through service-supply areas, demand areas, beneficiaries, exposure zones, flow pathways, and barriers to delivery.

Benefit-flow connectivity asks whether ecosystem-service benefits reach the people and places that need them. These benefits may include cooling, flood mitigation, improved air quality, pollination, recreation, mental health support, food production, and cultural services (Jato-Espino et al., 2023; Mitchell et al., 2015). Some benefits move through physical processes such as air circulation, hydrology, shade, or species movement. Others depend on human mobility, visibility, access, or institutional allocation.

Ecosystem-service supply alone cannot guarantee the delivery of benefits (Cortinovis & Geneletti, 2019; Mitchell et al., 2015). A park can produce cooling while failing to cool the most heat-exposed residents, especially when canopy cover, impervious surfaces, and vulnerable populations are unevenly distributed (Grove et al., 2015; Locke et al., 2021; Schwarz et al., 2015; Ziter et al., 2019). A wetland can store water, leaving downstream communities exposed if watershed processes and governance responsibilities are misaligned (Bergsten et al., 2014; McGlynn et al., 2023). Benefit-flow analysis asks where services originate, how they move, who receives them, who is excluded, and whether benefits reduce or reproduce inequality.

4.3 Socio-cultural connectivity

Socio-cultural connectivity concerns how people access, experience, interpret, value, and care for urban nature (Abdulla et al., 2025; Egerer & Anderson, 2020). It is assessed through communities, access routes, cultural practices, emotional relationships, stewardship networks, perceived safety, belonging, participation, and place attachment.

Socio-cultural connectivity asks whether urban nature is meaningfully accessible. Proximity matters, but it offers only part of the access. A green space may be within walking distance but remain difficult to use due to perceived safety concerns, poor maintenance, cultural exclusion, physical barriers, or emotional discomfort (Abdulla et al., 2025; Rigolon et al., 2021). A community may also sustain strong socio-cultural connectivity with a small, informal, or overlooked green space through stewardship, memory, identity, and everyday use (Egerer & Anderson, 2020; Egerer et al., 2020).

This domain is essential because urban nature is co-produced through social relationships. Stewardship, care, trust, cultural meaning, and participation influence whether green spaces are used, protected, maintained, and defended over time (Egerer & Anderson, 2020; Kabisch et al., 2022). Socio-cultural connectivity links urban nature planning to lived experience, environmental justice, public health, and democratic participation (Rigolon et al., 2021; Schlosberg, 2007; Wolch et al., 2014).

4.4 Governance connectivity

Governance connectivity concerns the relationships among institutions, actors, policies, funding systems, legal responsibilities, data systems, monitoring arrangements, maintenance practices, and accountability mechanisms that shape urban nature systems (Bergsten et al., 2014; Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023). It determines whether ecological, benefit-flow, and socio-cultural connections can be implemented, evaluated, corrected, and sustained (Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023).

Governance connectivity has four core components. Institutional coordination concerns the links among agencies, community organizations, landowners, utilities, watershed authorities, planning departments, park managers, and regulatory bodies. These links matter because urban nature systems often cross jurisdictions, sectors, land tenures, and administrative scales (Bodin, 2017; Kabisch et al., 2022; Keeley et al., 2022). Funding and maintenance concerns the relationship between capital investment, long-term financing, routine maintenance, repair, replacement, staffing, and stewardship. Governance, financing, monitoring, and long-term maintenance are recurring implementation challenges for urban nature-based solutions (Kabisch et al., 2022; Toxopeus & Polzin, 2021).

Information and monitoring connectivity concerns shared data systems, interoperable indicators, reporting responsibilities, feedback loops, and the capacity to evaluate outcomes over time (Kabisch et al., 2022; McGlynn et al., 2023; McPhearson et al., 2022). These capacities help determine whether ecological corridors are functioning, whether ecosystem-service benefits are reaching intended communities, whether socio-cultural access is meaningful, whether maintenance responsibilities are being met, and whether harms are emerging. Accountability connectivity concerns who remains answerable when urban nature systems fail, shift risk, reproduce exclusion, or decline after implementation (Bodin, 2017; Keeley et al., 2022; McGlynn et al., 2023).

Governance connectivity is a core domain because fragmented institutions and fragmented information systems can weaken well-designed ecological, service, or access networks. It determines whether alignment can become a durable planning condition instead of a temporary design intention.

These four domains identify what is connected. The equity, scale, and safety-risk lenses evaluate whether those connections are fair, scale-appropriate, and safe.

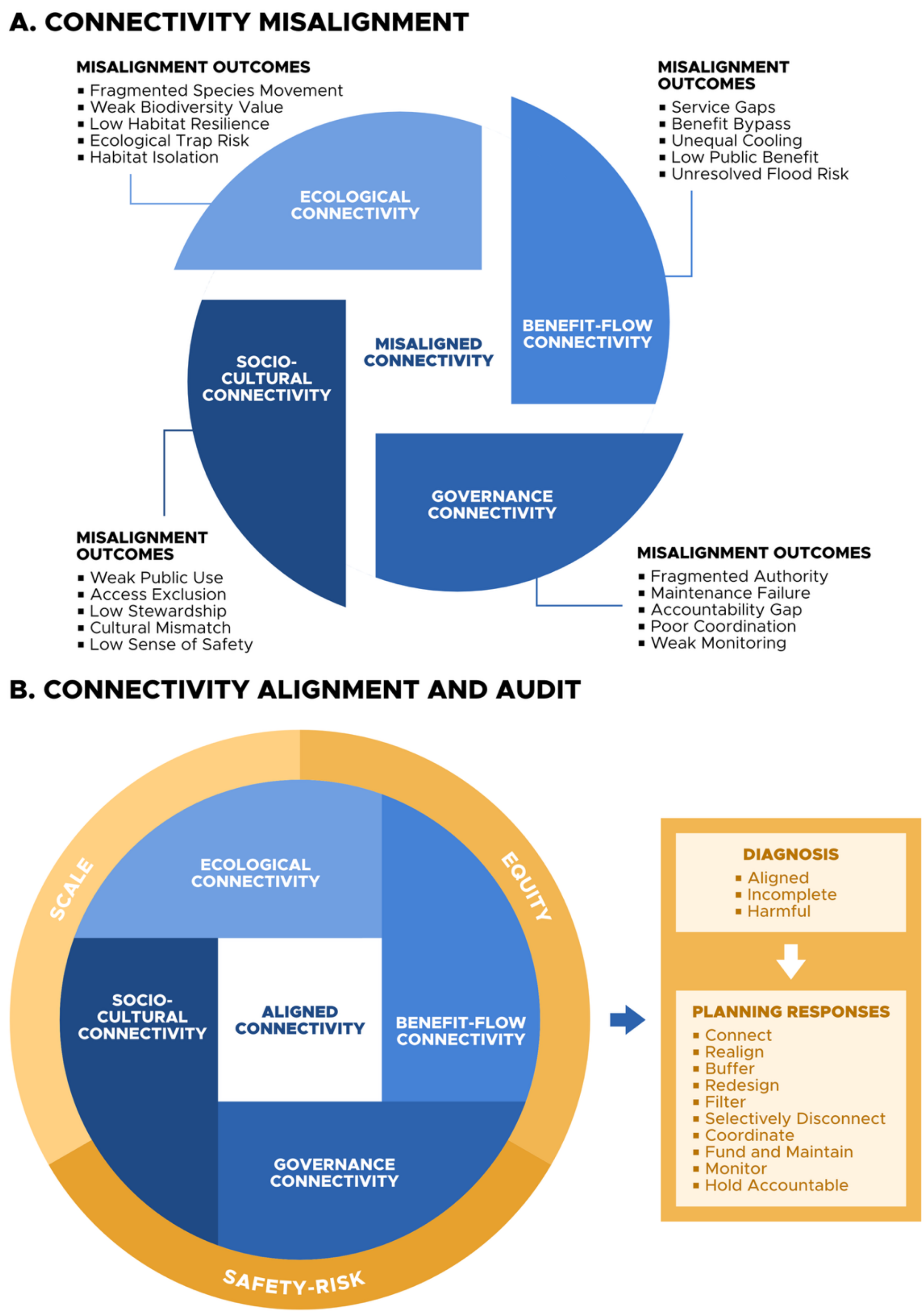

Figure 1. Connectivity alignment framework for urban nature. Panel A shows connectivity misalignment, where ecological, benefit-flow, socio-cultural, and governance connections are assessed separately, leading to incomplete links, benefit bypass, access exclusion, harmful flows, weak monitoring, and accountability gaps. Panel B shows connectivity alignment and audit, where the four domains are assessed together through equity, scale, and safety-risk lenses to diagnose aligned, incomplete, and harmful connectivity and guide planning responses.

5. Cross-cutting evaluative lenses

The four domains are evaluated through three lenses: equity, scale, and safety-risk. These lenses prevent the framework from treating connectivity as inherently beneficial.

5.1 Equity

The equity lens asks who benefits, who bears risk, who participates, and who is excluded. Connected urban nature can reproduce inequality when high-quality green spaces, ecosystem-service benefits, or decision-making power remain concentrated among privileged groups (Anguelovski et al., 2019; Rigolon et al., 2021; Wolch et al., 2014). Equity includes distributional, procedural, recognitional, and restorative dimensions. It concerns the distribution of benefits and burdens, the fairness of decision-making processes, the recognition of cultural meanings and histories, and the repair of past environmental harms (Rigolon et al., 2021; Schlosberg, 2007; Wolch et al., 2014).

This lens links differently to each connectivity domain. In ecological connectivity, equity asks whether biodiversity protection creates uneven burdens or restrictions. In benefit-flow connectivity, it asks whether services reach people facing high exposure or historical underinvestment. In socio-cultural connectivity, it asks whether access is safe, welcoming, culturally meaningful, and supported by everyday use. In governance connectivity, it asks whether communities have influence over decisions, monitoring, maintenance, and accountability.

5.2 Scale

The scale lens asks whether connectivity assessments and governance arrangements match the spatial and temporal scales at which ecological and social processes operate (Bergsten et al., 2014; McPhearson et al., 2022). Species movement may occur across metropolitan or regional landscapes while planning decisions are made parcel by parcel (Hilty et al., 2020; LaPoint et al., 2015; Molné et al., 2023). Cooling benefits may operate at the scale of streets, blocks, or neighborhoods while climate plans use citywide canopy indicators (Ziter et al., 2019). Hydrological processes may follow watersheds while management follows municipal boundaries (Bergsten et al., 2014; McGlynn et al., 2023).

Scale mismatch is a common source of connectivity failure (Bergsten et al., 2014; McPhearson et al., 2022). Ecological networks can be too coarse to guide local design. Accessibility metrics can be too local to capture regional inequality. Governance systems can be too fragmented to manage watershed processes. Monitoring systems can be too short-term to detect ecological succession, displacement, maintenance decline, or climate adaptation outcomes.

The scale lens asks four questions. At what scale does the problem operate? At what scale is the intervention designed? At what scale are benefits and risks distributed? At what scale is governance accountable?

5.3 Safety-risk

The safety-risk lens asks what harms may move through connected systems. Connectivity can support resilience and transmit disturbance, risk, or ecosystem disservices (Hardy et al., 2022; Hashemi & Darabi, 2026). Ecological corridors and networks may facilitate the spread of invasive species, pests, pathogens, or other unwanted ecological flows (Hashemi & Darabi, 2026; von Döhren & Haase, 2022). Increased access may disturb sensitive habitats or wildlife behavior (Marion et al., 2020). Blue-green infrastructure may leave downstream exposure unresolved when watershed processes and governance boundaries are mismatched (Bergsten et al., 2014; McGlynn et al., 2023). Green amenities may contribute to displacement pressures when greening lacks housing affordability, anti-displacement protections, or community control (Anguelovski et al., 2019; Wolch et al., 2014).

This lens challenges the assumption that connectivity should always be increased. Some places need controlled permeability, buffering, seasonal restriction, habitat protection, risk monitoring, or selective disconnection. Connectivity planning, therefore, needs thresholds and safeguards. It must ask what should be connected, slowed, separated, filtered, protected, or disconnected. Selective disconnection should respond to explicit ecological or social risks and be paired with alternative access, benefits, or participation where appropriate.

6. Applying the framework as a diagnostic-planning heuristic

The framework supports diagnosis, comparison, and planning judgment through context-specific indicators. It can support qualitative assessment, spatial analysis, participatory planning, scenario comparison, and mixed-method evaluation.

For any urban nature intervention, planners and researchers can begin with four domain questions.

Ecological connectivity: What species, habitats, ecological processes, or disturbance regimes are being connected? Are the connections functional for the organisms or processes of concern?

Benefit-flow connectivity: What benefits are produced, how do they move, and who receives them? Are benefits reaching the people and places with the greatest need?

Socio-cultural connectivity: Who can access, feel safe in, identify with, steward, or meaningfully use the space? Are there physical, cultural, emotional, institutional, or social barriers to use?

Governance connectivity: Which institutions, communities, agencies, landowners, funding systems, data systems, and monitoring arrangements control, maintain, evaluate, and remain accountable for the system? Do governance arrangements and information flows fit the ecological and social processes being managed?

The diagnosis then applies three lenses.

Equity: Who benefits, who is burdened, who decides, and whose meanings or needs are recognized?

Scale: Do ecological processes, benefit flows, social access, and governance authority operate at compatible scales?

Safety-risk: What harmful flows, disservices, disturbances, or unintended consequences may be amplified?

Table 2. Diagnostic conditions and planning responses for connectivity alignment

Diagnostic condition	Core question	Planning response
Connectivity alignment	Do ecological, benefit-flow, socio-cultural, and governance connections reinforce one another across relevant scales and avoid preventable harm?	Protect, maintain, monitor, and adapt.
Incomplete connectivity	Which necessary connections are absent, weak, poorly distributed, or mismatched across domains or scales?	Connect, realign, redesign, improve access, strengthen benefit pathways, coordinate governance, or fund maintenance.
Harmful connectivity	What risks, disturbances, burdens, disservices, exclusions, or displacement pressures move through the connected system?	Buffer, filter, redesign, regulate, monitor, compensate, reduce exposure, or selectively disconnect.

Different methods can support this diagnosis. Ecological connectivity may require habitat modeling, graph analysis, circuit theory, species movement data, or hydrological assessment. Benefit-flow connectivity may require ecosystem-service modeling, exposure mapping, thermal analysis, hydrological modeling, and beneficiary mapping. Socio-cultural connectivity may require interviews, participatory mapping, surveys, ethnography, accessibility analysis, and stewardship network analysis. Governance connectivity may require institutional analysis, policy review, stakeholder mapping, funding analysis, governance network assessment, data-system review, indicator comparison, and monitoring design (Cortinovis & Geneletti, 2019; Hilty et al., 2020; Kabisch et al., 2022; McGlynn et al., 2023; McPhearson et al., 2022).

7. Planning vignettes: diagnosing connectivity misalignment

The following vignettes show how the framework can reveal connectivity misalignment that single-domain approaches may miss. They are planning illustrations rather than empirical case studies.

7.1 Cooling corridors and unequal benefit delivery

Many cities are investing in tree corridors and connected green infrastructure to reduce heat exposure and strengthen urban resilience (Andersson et al., 2022; Kabisch et al., 2022; Ziter et al., 2019; Zúñiga-Terán et al., 2020). A conventional assessment might ask whether canopy cover has increased or whether green corridors are spatially continuous. An alignment assessment asks whether cooling benefits reach heat-vulnerable residents, whether tree investments are concentrated in neighborhoods with stronger maintenance capacity, and whether planting programs are linked to long-term watering, replacement funding, monitoring, and community feedback.

This vignette reveals possible misalignment between structural connectivity and benefit-flow connectivity. A tree corridor may be spatially continuous and deliver uneven cooling benefits. Planning responses may include redirecting canopy investment toward heat-vulnerable streets, integrating heat-risk and social-vulnerability mapping, funding long-term maintenance, protecting renters from displacement pressure, and monitoring cooling outcomes instead of canopy extent alone (Anguelovski et al., 2019; Grove et al., 2015; Locke et al., 2021; Schwarz et al., 2015; Wolch et al., 2014; Ziter et al., 2019).

7.2 Biodiversity corridors and socio-cultural exclusion

Urban river corridors are often restored to improve habitat continuity, blue-green connectivity, and species movement (Hilty et al., 2020; LaPoint et al., 2015; Molné et al., 2023). A conventional ecological assessment might evaluate habitat area, riparian continuity, vegetation structure, or species movement. An alignment assessment also asks whether nearby communities can safely access, identify with, and help steward the restored corridor. Residents may avoid a corridor because of poor lighting, aggressive policing, inaccessible entrances, flooding, poor maintenance, or cultural exclusion (Abdulla et al., 2025; Rigolon et al., 2021).

This vignette reveals misalignment between ecological connectivity and socio-cultural connectivity. Planning responses may include community co-design, culturally responsive programming, stewardship partnerships, improved entrances, safer routes, careful lighting, maintenance agreements, and zoning for sensitive habitats.

7.3 Flood infrastructure and downstream risk transfer

Blue-green flood infrastructure is increasingly used to manage stormwater and climate risk (Andersson et al., 2022; Browder et al., 2019; Zúñiga-Terán et al., 2020). A conventional infrastructure assessment might evaluate storage capacity, runoff reduction, or local flood-depth reduction. An alignment assessment follows water, risk, and responsibility across the watershed. It asks whether upstream interventions account for downstream exposure, whether municipal boundaries match watershed processes, and whether maintenance failure in one jurisdiction increases risk elsewhere.

This vignette reveals harmful connectivity and governance misalignment. Hydrological systems remain connected while governance systems remain fragmented (Bergsten et al., 2014; McGlynn et al., 2023). Planning responses may include watershed-scale coordination, cross-jurisdictional agreements, shared hydrological data, risk-distribution analysis, maintenance funding, and accountability mechanisms that evaluate who benefits and who remains exposed (Barnett & O'Neill, 2010; Bergsten et al., 2014; McGlynn et al., 2023).

7.4 Sensitive habitats and selective disconnection

Some urban biodiversity strategies seek to connect people more closely with nature through trails, boardwalks, access points, and interpretive programming. These interventions can strengthen environmental education, recreation, and stewardship. Increased access can also disturb wildlife, compact soil, introduce invasive species, or damage sensitive habitats (Hashemi & Darabi, 2026; Marion et al., 2020).

An alignment assessment examines whether socio-cultural connectivity is compatible with ecological sensitivity. Some places may need seasonal closures, boardwalk routing, buffer zones, pet restrictions, invasive-species controls, or limited public entry. Selective disconnection can support ecological integrity when permeability creates risk. It should be used with care, grounded in evidence, and paired with alternative access, benefit, or participation where appropriate.

Together, these vignettes show that connectivity problems rarely sit within a single domain. A corridor, park network, flood system, or habitat restoration can appear successful through one metric and remain misaligned when ecological function, benefit delivery, lived access, governance capacity, equity, scale, and safety-risk are considered together.

8. Alignment audits for urban nature

Connectivity alignment changes the practical question facing urban nature planning. The question extends beyond where corridors, parks, trees, wetlands, or blue-green infrastructure should be added. The key issue is whether these interventions reinforce biodiversity, benefit delivery, socio-cultural access, and governance capacity across relevant places, communities, species, institutions, and timescales.

This shift calls for alignment audits. An alignment audit is a flexible diagnostic process that compares ecological, benefit-flow, socio-cultural, and governance connectivity within a single planning geography. It identifies where connectivity is aligned, incomplete, or harmful. It can be implemented through matrices, map overlays, scenario comparisons, participatory review, governance assessment, or monitoring protocols. A single score is optional. The main value lies in making cross-domain relationships visible before design, investment, or implementation decisions are finalized.

Alignment audits also require information connectivity. Shared indicators, interoperable datasets, monitoring responsibilities, reporting systems, and feedback mechanisms allow agencies and communities to detect whether connectivity is aligned, incomplete, or harmful over time (Kabisch et al., 2022; McGlynn et al., 2023; McPhearson et al., 2022). Information connectivity turns alignment audits into adaptive governance tools that track ecological function, benefit delivery, socio-cultural access, maintenance performance, risk transfer, and accountability.

Many plans already map green space, canopy cover, habitat corridors, flood infrastructure, or park access. These inventories are useful. They can also create a false sense of success when domains are assessed separately. An alignment audit would ask whether habitat networks overlap with benefit-demand areas, whether cooling corridors reach heat-vulnerable communities, whether accessible green spaces are ecologically functional and culturally welcoming, whether flood interventions avoid transferring exposure downstream, and whether governance systems have the authority, funding, maintenance capacity, data-sharing systems, monitoring responsibility, feedback mechanisms, and accountability needed to sustain the system.

Alignment audits expand the planning vocabulary beyond connection. The appropriate response to misalignment may be to connect where connectivity is incomplete, realign where domains or scales are mismatched, buffer where harm may travel, redesign where benefits bypass intended users, or selectively disconnect where permeability creates ecological or social risk. The methodological challenge lies in interpretation. Overlapping layers may indicate synergy, separation may signal exclusion, and connection itself may create risk.

The next step in connectivity research is to provide better evidence for deciding when to connect, when to realign, when to buffer, and when to avoid connection.

9. Conclusion: Designing connected and aligned urban nature systems

Urban nature systems are shaped by ecological processes, ecosystem-service flows, socio-cultural relationships, and governance systems. These forms of connectivity can reinforce one another. They can also remain incomplete, operate at mismatched scales, bypass vulnerable groups, transfer risk, or amplify harm.

This Perspective defines connectivity misalignment as a condition in which connections in one domain coexist with disconnection, inequity, risk, weak monitoring, or weak governance in another. It proposes a connectivity alignment framework for diagnosing and planning to address this problem. The framework evaluates ecological, benefit-flow, socio-cultural, and governance connectivity through equity, scale, and safety-risk lenses. It identifies incomplete connectivity and harmful connectivity as two recurring forms of misalignment.

The framework challenges the assumption that more connectivity always produces better urban nature systems. Some situations call for stronger corridors, access routes, benefit flows, and governance networks. Others call for buffering, redesign, controlled permeability, or selective disconnection. The planning task is to connect carefully, govern responsibly, and align urban nature systems with biodiversity, equity, and resilience goals.

The future of urban nature planning depends on making alignment visible before investments are made and measurable after implementation. Alignment audits can help planners identify where connected landscapes support biodiversity, where benefits bypass vulnerable communities, where access remains unsafe or exclusionary, where governance systems lack capacity, and where connectivity itself creates harm. Connected urban nature becomes durable, just, and resilient when ecological function, benefit delivery, lived access, monitoring, maintenance, and accountability reinforce one another across scales.

Data availability

No new data were generated or analyzed in this Perspective.

Author contributions

Conceptualization: Allen Glen Gil. **Investigation:** Allen Glen Gil. **Methodology:** Allen Glen Gil. **Writing – original draft:** Allen Glen Gil. **Writing – review and editing:** Allen Glen Gil.

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During the preparation of this manuscript, the author used ChatGPT by OpenAI to support language editing, structural refinement, and clarity checks. The author reviewed, revised, and verified all AI-assisted text and takes full responsibility for the final content of the manuscript.

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