



Synthesis

Exploring multispecies co-design for social-ecological transformation

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ABSTRACT. As urbanization intensifies, communities encounter increasing challenges in designing, planning, and managing urban green spaces. Co-design offers a just and participatory approach that can unite diverse interest-holders to identify challenges and devise transformative solutions to complex urban issues such as green space governance. However, while co-design is acknowledged for its potential to foster learning and systemic change, it largely remains anthropocentric, often overlooking multispecies perspectives in planning, policy, and academia. We present a case study from New York City that examines how a multispecies co-design approach may enhance social-ecological systems transformation by exploring participants' learning experiences and perceptual shifts. The paper begins by exploring the literature on co-design and multispecies thinking within social-ecological systems and their contribution toward transformations, establishing the conceptual groundwork for integrating non-human actors into urban planning. We then present a case study of a multispecies co-design process in New York City and explore how engaging with it contributes to systems transformation. Findings from the case study reveal key motivations for participation, drivers of learning during the process, and emergent transformative solutions. By analyzing these dynamics, this research illustrates how co-design, which integrates multispecies perspectives, may refine ecological decision making and encourage deeper engagement with urban nature. The study argues that integrating multispecies approaches into co-design practices is essential for fostering sustainable societies. The paper concludes with guiding principles for researchers and practitioners seeking to implement inclusive co-design processes in social-ecological systems, particularly in complex urban environments such as New York City.

Non-Technical Summary

As cities grow, it becomes more difficult for communities to design and care for green spaces in ways that work for everyone. Co-design is a collaborative approach that brings different people together to identify problems and create shared solutions, but it usually focuses only on human needs. This paper explores how including non-human life, such as plants and animals, in co-design can lead to better outcomes for both people and nature. Using a case study from New York City, the research looks at how a multispecies co-design process changed how participants thought, learned, and acted in relation to urban green spaces. The findings demonstrate why people chose to participate, how learning occurs during the process, and how new, more sustainable ideas emerge. Overall, the study shows that designing cities with both humans and other species in mind may support healthier urban ecosystems and more engaged communities, offering practical guidance for doing this in complex urban settings.

Key Words: *co-design; multispecies; New York City; participatory research; qualitative research; social-ecological transformation; urban wild spaces*

INTRODUCTION

As communities face increasing challenges associated with urbanization, such as access to green spaces (Rigolon 2016, Csomós et al. 2020, Park and Guldmann 2020), novel collaborative strategies are critical for developing solutions within urban planning and design that respond to communities' needs and challenges. Co-design is a decision-making process where diverse actors leverage their knowledge and perspectives to identify challenges and explore solutions for system transformation (O'Donnell et al. 2025). This integrative, creative, and reflexive process is characterized by active participation, encouraging participants to have a voice, agency, and a sense of ownership throughout the design process. The co-design process can empower communities by actively involving them in shaping their environments, aligning solutions with their needs and lived experiences (Zamenopoulos et al. 2021).

Despite the benefits of collaborative approaches, significant constraints remain when implementing methods such as co-design (Nguyen et al. 2024), including institutional/policy support (Sarabi et al. 2021) and resources (Murphy et al. 2023). Furthermore, despite the recognized potential of co-design to foster learning and transformation from participants (Moser 2016), the approach typically privileges human-centered perspectives rather than non-anthropocentric voices. As a result, multispecies or more-than-human approaches to collaboration are frequently overlooked and undervalued within human-centered research, planning, and policy (Houston et al. 2018, Van Patter et al. 2022). This lack of multispecies recognition within urban planning continues to be reproduced through mainstream planning theory and practice (Metzger 2015). Increasingly, scholars argue that urban planning and design may benefit significantly from the development and incorporation

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of multispecies approaches (Hinchliffe and Whatmore 2006). This is because a multispecies planning approach acknowledges the interconnectedness of all species and ecosystems, aiming for a more holistic and equitable approach to environmental management and urban planning, increasing biodiversity and the well-being of both humans and non-human species (Houston et al. 2018, Pineda-Pinto et al. 2022, Pineda-Pinto et al. 2023).

The following paper presents a case study in New York City that examines how engaging with a multispecies co-design process contributes to systems transformation by exploring participants' learning experiences and perceptual shifts. A "multispecies co-design process" is understood as a place-based participatory approach that foregrounds the perspectives, needs, and interactions of both human and non-human life forms to foster recognition and care of urban environments. These processes are critical not only for deepening human-nature relations but also for dissolving the nature-culture binary (Parker et al. 2022). The case presents an opportunity to study a combination of urban ecosystems, with a particular focus on urban wild spaces (UWS). UWS are less-managed ecosystems with unique characteristics, such as species' agency and autonomy, which shape their spatial and functional structure with limited management interventions (Cantrell et al. 2017). UWS are frequently undervalued because of their perception as unkempt, underutilized, or lacking economic function (Jorgensen and Tylecote 2007), which leads to their neglect in planning and policy decisions. Nevertheless, they possess immense potential for biodiversity conservation, climate resilience, and community well-being by providing habitats, mitigating urban heat, supporting mental health, and fostering ecological stewardship (Francis and Chadwick 2013, Marris 2013, Palomo et al. 2016). The autonomous and spontaneous qualities of UWS make them particularly well suited for the application of a multispecies approach. Such spaces provide a valuable context for examining non-human species' capacities, needs, and interactions, as well as the emergent social-ecological relationships that arise through their co-presence with humans.

The study asks: How does a multispecies co-design process shape meanings, learning, and relational connections between participants and more-than-human life within an urban wild context in New York City? Rather than seeking to generalize outcomes or measure long-term transformation, the study adopts an exploratory, case-based approach to examine how multispecies co-design operates in practice and what kinds of shifts it enables during the process itself. The paper begins by reviewing existing literature on co-design processes and multispecies thinking to build a conceptual foundation. It uses a detailed case study to analyze participants' motivations and engagement, the learning drivers, and perspective shifts that occurred during co-design workshops. Additionally, it examines the types of solutions and principles expressed throughout the process. Although the study does not evaluate long-term ecological or governance outcomes, it offers an empirically grounded account of how multispecies co-design can reshape participants' understandings, relationships, and actions within UWS. By doing so, it provides insights and guiding principles that can be applied by researchers and practitioners seeking to implement multispecies co-design in various urban social-ecological settings.

CO-DESIGN PROCESSES FOR SOCIAL-ECOLOGICAL TRANSFORMATIONS

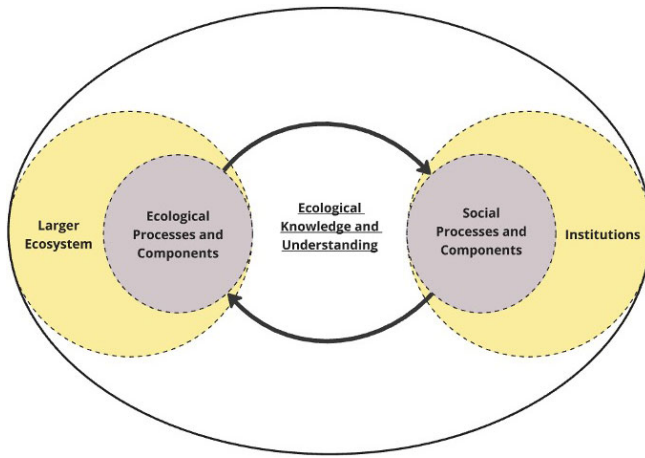
As urbanization accelerates, challenges such as equitable access to green spaces, habitat protection, and climate adaptation intensify (Bulkeley 2013, Elmqvist et al. 2013, Rigolon 2016). Governments often lead urban green space management (Azadi et al. 2011), but frequently lack meaningful community engagement, resulting in underuse, poor maintenance, and missed ecological and social benefits (Arnstein 1969, McKinney 2002). Research shows that excluding communities from nature-based solutions undermines project sustainability and stewardship (Kabisch et al. 2015, Frantzeskaki et al. 2016), while collaborative approaches enhance resilience, social networks, and environmental awareness (Raymond et al. 2017). Partnerships among interest-holders such as planners, businesses, and volunteers ultimately strengthen long-term management and sustainability (Buijs et al. 2016).

Co-design, integral to co-creation, is gaining traction in sustainability science (Asah and Blahna 2020, Melles 2021). Recognized for enhancing decision making (Reed 2008), adaptive governance (Folke et al. 2005), and social learning (Pahl-Wostl 2009), co-design also supports social-ecological systems (SES) adaptation (Pereira et al. 2020). International initiatives, such as Future Earth, emphasize stakeholder engagement beyond academia for sustainability (Frantzeskaki and Rok 2018, Tembo et al. 2021). However, resource constraints often limit public participation, hindering governance transformation and conservation strategies. Transformative change arises when structures become unstable, necessitating systemic reconfigurations in governance, perceptions, and ecological dynamics (Folke et al. 2010, IPBES 2019). Unlike incremental adjustments, transformation involves radical shifts in power structures, institutions, and societal values (Chapin et al. 2010, Olsson et al. 2010, McPhearson et al. 2021). Co-design is not merely a tool for understanding change but an active driver that fosters learning, engagement, and innovation (Moser 2016).

Recognizing the power of co-design requires the consideration and deeper engagement with the complexity of systems. In this context, the SES concept is crucial for considering and integrating both human and non-human actors and elements in urban planning. This paper utilizes the original SES model (Fig. 1; Berkes et al. 2000), which links ecosystems with management practices through ecological knowledge shaped by local institutions (Colding and Folke 2001). SES governance encounters challenges such as balancing conservation with resource use (Hilborn et al. 2020), fragmentation (Fleck 2016), and power imbalances (Dressler et al. 2010).

Effective social-ecological transformations necessitate systemic shifts in mental models, institutions, management routines, and actor roles (Westley et al. 2013, IPBES 2019). Participatory processes such as co-design encourage inclusivity, collaboration, and dialogue, facilitating knowledge exchange across diverse communities, including epistemic and practice-based groups (Wagner et al. 2019). This integration fosters social learning (Reed et al. 2010), where participants question assumptions, explore innovations, and alter perspectives through critical reflection (Mezirow 1997, Pereira et al. 2018a). Evolutionary design approaches further promote systemic change in SES (Costanza 2014), underlining the importance of collaborative knowledge development at multiple scales (Webb et al. 2018).

Fig. 1. The social-ecological systems (SES) framework comprises complex, dynamic ecosystems, management practices, and institutions, with ecological knowledge and understanding linking these two primary components (adapted from Colding and Barthel 2019).



Co-design fosters transformative learning by exposing participants to diverse experiences, questioning ingrained assumptions, and exploring novel solutions. Initiatives such as the Lower Manhattan Coastal Resilience Plan and New York City Housing Authority housing enhancements illustrate this through participatory workshops, interactive mapping, and visioning sessions (Hester Street 2024). These engagements facilitate reciprocal learning as planners gain insights from lived experiences while residents deepen their understanding of urban systems and advocacy tools. Transformations in SES are inherently unpredictable, arising from interactions across different scales and actors (Folke et al. 2010). Instead of attempting to control change, the emphasis is on navigating emergent transitions (Pereira et al. 2018b). Considering the multilevel and multiphase nature of SES transformations, integrating diverse sources of knowledge is crucial for capitalizing on windows of opportunity for innovation (Olsson et al. 2006, Westley et al. 2011, Merrie and Olsson 2014).

The increased focus on inter- and trans-disciplinary research and practice within sustainability science (Thompson Klein 2004, Clark 2007, Spangenberg 2011, Moser 2016) has reshaped the relationship between researchers and their surrounding communities (Trencher et al. 2014, Leal Filho et al. 2022), with them conducting more socially embedded and solutions-orientated research (Miller et al. 2014, Balvanera et al. 2017). Working with existing community structures can strengthen the transformative process (Bisht et al. 2025). While including a wider set of collaborators is often challenging, seeking a diversity of interest-holder inclusion is recommended to enhance the outcomes of collaborative processes (O'Donnell et al. 2017, Pérez Rubi and Hack 2021).

MULTISPECIES THINKING IN CO-DESIGN

In the context of complex systems and global-local dynamics, recent scholarship has challenged the view that co-design is a human-only activity (Romani et al. 2022, Bianchini et al. 2023).

Over the past decade, there has been an ontological shift toward embracing multispecies and more-than-human perspectives, sparking diverse approaches in the social sciences, critical geographies, and humanities (Kennedy 2022). These include concepts such as more-than-human geographies (Lorimer 2012), multispecies ethnography (Kirksey 2014, Locke and Muenster 2015), and posthumanism in design (Forlano 2017). The approach encourages considering the needs of all human and non-human life forms and their interactions. As ecologists and anthropologists increasingly recognize humanity as a component of an entangled web of life, many suggest adopting a perspective transcending anthropocentrism to assist with collaborative survival (Morton 2016, de La Bellacasa 2017, Groutars et al. 2024). In this sense, Roudavski (2020) argues that design researchers must engage non-human life forms as collaborators to foster a future of multispecies cohabitation, a critical strategy for addressing the planetary crisis. For instance, achieving a meaningful transformation of urban life requires abandoning anthropocentric biases in design and governance, thereby extending emancipatory efforts to include non-human actors.

Approaches that integrate the needs, roles, and agency of more-than-human life forms into urban design, planning, and governance can support biodiversity-sensitive design (González-Duarte and Méndez-Arreola 2024), climate resilience (Dolejšová et al. 2020), and public space quality (Fieuw et al. 2022). However, knowledge gaps remain on the role of collaborative methods employing a multispecies approach and on how they contribute to meaningful learning moments. Although co-design is recognized as a process contributing to learning and transformation, the impacts of its use or application in combination with a multispecies approach are underexplored or in their infancy.

Existing methods connecting design and SES, such as participatory landscape planning, nature-based solutions, ecosystem services frameworks, and adaptive co-management, have enhanced the understanding of how human collaboration can foster ecological outcomes in urban settings (Ahern et al. 2014, Haase et al. 2014, Armitage et al. 2015, Kabisch et al. 2016, Prodanovic et al. 2024). However, these approaches often retain an anthropocentric focus, viewing non-human life as benefiting from human decisions rather than as active participants shaping design visions and governance (Buckton et al. 2023, Roudavski 2024). Meanwhile, scholarship on multispecies has been critiqued for limited engagement with participatory design, as well as tendencies toward abstraction and romanticization of ecological processes, which can overlook urban power relations, institutional constraints, and social inequalities (Kirksey and Helmreich 2010, Ernstson 2013, Jørgensen 2015, Houston et al. 2018). This creates a critical gap in understanding how co-design methods can practically incorporate multispecies perspectives when working in complex SES.

Although multispecies approaches offer compelling frameworks for rethinking urban relations (Rupprecht et al. 2020, Bonthoux and Chollet 2024), in particular in wild, contested, or marginal spaces, they also raise significant conceptual and practical challenges that complicate their application in real-world settings. These include difficulties in representing non-human agency without anthropomorphic projection (Haraway 2023), tensions between ecological spontaneity and regulatory urban governance

(Pineda-Pinto et al. 2025), and the risk of romanticizing wildness in landscapes shaped by histories of contamination, infrastructure, and social inequalities (Waters 2025). In dense urban settings, initiatives to work with UWS may create conflicts among human safety, maintenance routines, and the needs of non-human habitats, revealing unequal distribution of risks and benefits. This study approaches these challenges not by expecting direct non-human involvement or specific ecological restoration results, but by viewing multispecies co-design as a situated, experimental process. The workshops utilize engagement and exploration to provide spaces where participants can reflect on these tensions, consider the boundaries of representation, and investigate how multispecies perspectives may shape urban decision making in uncertain contexts. In this sense, the study offers an empirically grounded account of multispecies co-design as a mediated and reflexive practice, illustrating how participatory methods can highlight non-human considerations in urban design without assuming direct representation or agency.

METHODOLOGY

The study employs a case study methodology to explore how multispecies co-design contributes to systems transformation along the Greenpoint-Williamsburg waterfront in New York City. A mixed-methods approach combines co-design workshops, ex-ante and ex-post surveys, and follow-up interviews to gather qualitative insights into participants' perceptions and experiences of participating in a co-design process embedded in multispecies thinking. Three envisioning workshops engaged 27 participants, including urban planners, academics, and residents, representing diverse perspectives. These groups were selected for their ability to integrate practical expertise, research-based insights, and community values (Wagner et al. 2019). Seven of these participants also participated in structured post-workshop interviews to triangulate findings (Tasker and Cisneros 2019). The study adopted an inquiry-focused approach, using open-ended questions to promote free expression and reflection (Friesen and Scott 2013). Thematic analysis techniques were applied to analyze the collected data systematically.

Study area: Greenpoint-Williamsburg waterfront, New York, NY, USA

The Greenpoint-Williamsburg waterfront, bordering the East River in North Brooklyn, is located within one of the world's most densely populated urban areas: New York City. The site features park facilities, including soccer fields, playgrounds, and abandoned industrial sites. The East River, Newtown Creek, and Bushwick Creek historically supported both freshwater and saltwater riparian ecosystems (Fig. 2). Indigenous communities, including the Keskachauge clan of the Lenape, originally inhabited this area, known as Lenapehoking. Urbanization began with Norse, Dutch, French Huguenot, and British settlers in the 1600s and 1700s, accelerating in the mid-1800s when shipyards, housing, and heavy industry replaced farmland. Manufacturing, including coal-tar gas production and oil storage, has left a legacy of contamination (Dennis 2025, NYS Department of Environmental Conservation 2026).

In recent decades, the North Brooklyn waterfront has undergone rapid transformation by rezoning, residential development, and public investment into green infrastructure. The sites in this case study were rezoned in 2005 to support a 28-acre park as part of

Fig. 2. This map partially represents the original Bushwick Creek on today's street grid. Marsha P. Johnson State Park (1), Bushwick Inlet Park (2), and 50 Kent Park (3) are highlighted in red above, where the co-design workshops took place. The surrounding parcels shaded in yellow are currently not open to the public (Google Maps).



NYC Parks' Greenpoint-Williamsburg Waterfront Open Space Master Plan. This plan resulted in the conversion of former industrial parcels into parks and recreational spaces, alongside remediation efforts. Although these developments remain in the early stages, environmental injustices persist, with communities continuing to face unequal access to ecological benefits. As a result, the Greenpoint-Williamsburg waterfront represents a contested landscape where ecological recovery, real estate development, and multispecies habitation intersect under conditions of uncertainty and transition. Community groups, such as Friends of Bushwick Inlet Park (FBIP) and the North Brooklyn Parks Alliance, are now advancing plans for urban wilding (the regeneration of ecosystems with minimal human intervention) along the coastline. To support this effort, the co-design workshops in this study were conducted to develop collaborative guidelines for the North Brooklyn Parks Alliance to work with existing UWS in ways that are mindful of the ecological processes that have emerged with little human interference. FBIP is a community-driven advisory group focused on advocacy to fulfil the city's promises to develop the park, protect it from new development, and support cultural programming. The North Brooklyn Parks Alliance is a larger non-profit coalition focused on the management and current and long-term maintenance of the existing city parcels (as opposed to state oversight of parkland, as in the case of Marsha P. Johnson). They have a full-time gardener dedicated to 50 Kent and plan to expand staffing as the park expands. It collaborates with local "Friends" groups such as FBIP, government agencies, and civic actors to raise funds, coordinate volunteers, and foster community engagement around green infrastructure in a densely built urban environment.

The Greenpoint-Williamsburg waterfront has a complex history of extraction, contamination, and redevelopment that shapes the site. It highlights the challenges of working with UWS in dense

Table 1. Workshop information, including the number of participants and their representative grouping, the location of the workshop, and the date it was held. During the identification and invitation process, potential participants were grouped into three categories: communities of practice (e.g., urban planners and designers), epistemic communities (e.g., academics and policy makers), and interest groups (e.g., residents and community groups).

Location	Date	Workshop & survey participants	Interview participants
50 Kent Park	18 October 2024	8 x Community of Practice 4 x Epistemic Community 1 x Interest Group	N/A
Bushwick Inlet Park	23 October 2024	2 x Community of Practice 2 x Epistemic Community 3 x Interest Group	2 x Community of Practice 1 x Interest Group
Marsha P. Johnson State Park	2 November 2024	2 x Community of Practice 3 x Epistemic Community 2 x Interest Group	1 x Community of Practice 2 x Epistemic Community 1 x Interest Group

cities, where balancing recreation, conservation, and commercial interests requires ongoing negotiation. Multispecies co-design provides a framework to mediate these interests by encouraging dialogue, shared responsibility, and more inclusive environmental decision making.

Workshop design

Three workshops were held at 50 Kent Park, Bushwick Inlet Park, and Marsha P. Johnson State Park, selected for their distinct ecosystems, including waterfront access, UWS, and managed green areas. A total of 27 individuals participated in the workshops (see Table 1), completed ex-ante and ex-post surveys, and seven individuals participated in interviews following the workshops. The focus was on participants' experiences with UWS, where species exert agency and shape ecosystems with minimal management, aligning with a multispecies approach that explores interspecies interactions and social-ecological relationships. The authors collaborated with North Brooklyn Parks Alliance to identify and invite participants.

The workshops, conducted between October and November 2024, featured three key activities: wild transect walks with "noticing" (Tsing 2015, Biggs et al. 2021, Poikolainen Rosén et al. 2022), storytelling (Nijs et al. 2020, Romani et al. 2022, Gonsalves et al. 2023), and multispecies role-playing (Taboada et al. 2024). These methods were identified through a systematic review of co-design methods and techniques (O'Donnell et al. 2025) and selected for foregrounding embodied engagement and narrative sense-making. Compared with more conventional methods, such as stakeholder mapping or interviews, "noticing" supports situated ecological attunement; storytelling enables relational meaning-making; and role-playing allows participants to reflect on and experiment with non-human perspectives. During the role-playing activity, participants were assigned human and non-human species identified during the "noticing" activity, which typically included trees, plants, insects, and mammals. Participants were not provided with information about the species, but were encouraged to work as a group when discussing the assigned species' characteristics and connections. O'Donnell (2025) provides a detailed account of the planning, preparation, and implementation of these workshops.

When considered through Arnstein's ladder of participation for human stakeholders (1969), the workshops would be positioned between consultation and partnership; however, applying this

framework to a multispecies co-design process reveals a key ethical limitation, as non-human participation necessarily occurs through human-mediated representation. Within emerging frameworks for more-than-human participation (Roudavski 2024), the workshops are best understood as operating at the level of proxy-based ecological representation, where non-human agency is articulated through human interpretation rather than direct participation. Although multisensory engagement, storytelling, and roleplaying were employed to address this challenge, these practices remain shaped by human knowledge systems, assumptions, and priorities, constraining the extent to which multispecies perspectives can be authentically included (Haraway 2023). Accordingly, the workshops serve as a mediated form of multispecies co-design that fosters reflexive learning and collaborative reframing, approximating, rather than achieving, true multispecies participation.

Each workshop lasted approximately 2–2.5 hours and began with a brief introduction to the concept of UWS, drawing on established literature (Gandy 2016, Kowarik 2018, Threlfall and Kendal 2018). This was followed by the three structured activities (Fig. 3), interspersed with facilitated reflective discussions. Participants were invited to explore interdependencies, perceived threats, and possibilities for collaboration across the spaces. The workshops concluded with a collective synthesis, in which facilitators summarized key themes, tensions, and opportunities that emerged, providing a basis for final participant reflections. All workshops were facilitated by a lead researcher and a research assistant, whose roles included supporting inclusive participation, responding to participants' needs, and systematically documenting the process through video recordings and field notes. The lead researcher has a background in examining SES through collaborative research and practice. As such, the study is informed by a constructivist epistemology and a relational, holistic understanding of nature. Recognizing that these ontological and epistemological positions shape research design and interpretation (Holmes 2020), reflexive practices were employed to critically examine how such commitments might influence the analysis of multispecies co-design processes.

Surveys and interviews

Workshop participants completed ex-ante and ex-post workshop surveys, collecting 27 responses. Initially intended to establish baselines and assess learning outcomes (Stopher and Greaves 2007), the surveys also encouraged reflection on the co-design

Fig. 3. Details of the methods employed during the co-design workshops, including images of participants during the process (adapted from O'Donnell et al. 2026). Photos by M. O'Donnell (1) and C. Pierson (2,3).



process, particularly regarding how a multispecies approach influences perceptions and site transformations. Furthermore, structured post-workshop interviews with seven participants provided deeper insights into their experiences and the significance of engagement (Monroe 2002). Participants were asked to describe their experiences and perceptions of the workshops and to discuss why they think engaging with the process was important.

Data analysis

A thematic analysis (Clarke et al. 2015) was conducted on workshop, survey, and interview data to capture participants' values and their relationships with the site and other species. In line with Rocks et al. (2007), researchers documented observations throughout the workshops to support their analysis. The sessions were video-recorded, transcribed using Fireflies AI, and triangulated across multiple data sources (Tasker and Cisneroz 2019). Survey data, collected via Google Forms and organized in Excel, underwent initial coding guided by four key questions: (1)

Why did participants join the workshops? (2) How did they develop a new appreciation for UWS? (3) What aspects of the workshop led to perceptual changes? (4) What are the key actions for transformation at this site (Fig. 4)? Both deductive and inductive approaches informed the generation of new insights (Braun and Clarke 2006).

The thematic analysis identified recurring patterns across data from workshops, surveys, and interviews (see Appendix 2). Following Braun and Clarke (2006), analysis proceeded through familiarization, initial coding, theme development, and refinement. A theme, as defined by Clarke et al. (2015), captures key aspects of the data in relation to the research questions. A deductive approach was applied to questions 1 and 4, while an inductive approach was used for questions 2, 3, and 4, given their greater contextual depth. The analysis was iterative and reflexive, with themes continually refined through comparison across data sources and methods. Reflexivity was integrated throughout this process, with researchers critically examining how their own ontological and epistemological positions, particularly commitments to relational and multispecies worldviews, might shape their interpretations (Holmes 2020). To enhance analytical rigor, interpretive decisions were recorded in analytic memos. Emerging themes were then discussed among the authors as a form of collaborative critique, focusing on evidentiary support, alternative interpretations, and the inclusivity and limitations of the multispecies co-design process.

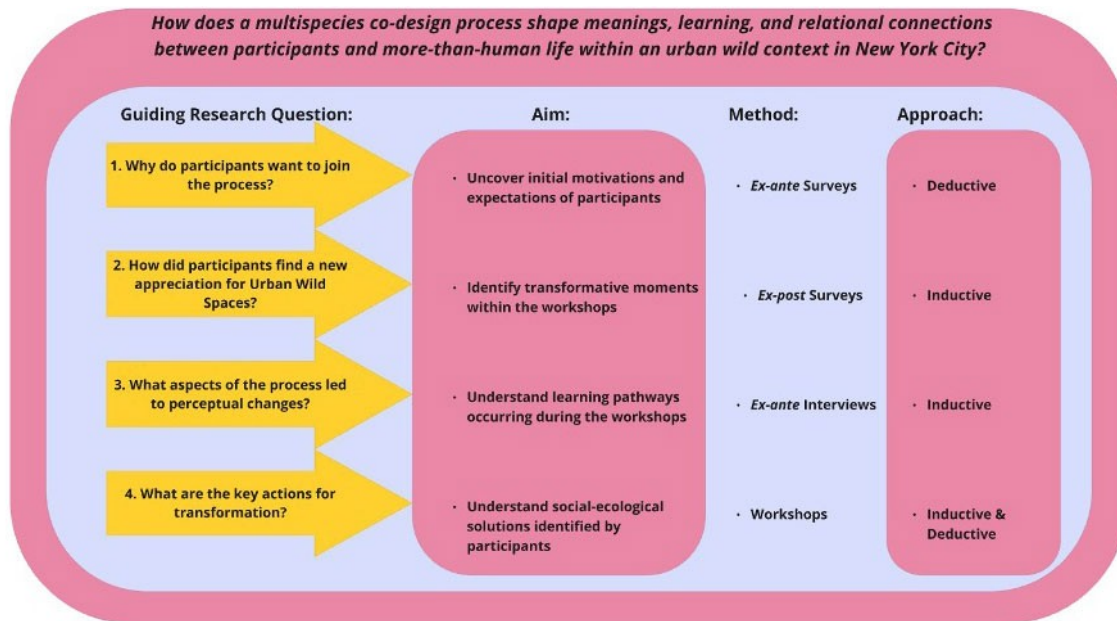
RESULTS

Four significant themes emerged from this research process: learning-driven motivations for participation; social mechanisms that deepened appreciation of urban wild spaces (UWS); immersive, imaginative, and embodied practices that fostered shifts in multispecies perspectives; and the generation of transformative, place-based solutions for social-ecological change. Together, these themes reflect a co-design process grounded in multispecies thinking and illustrate how such approaches influence perceptions of, and attitudes toward, UWS. To start, participants were questioned about their motivations for engaging in the co-design process. The findings indicate that learning was the primary motivator for participation. The most frequently reported motivator (82.4%) was the desire to learn about UWS, which aligned with the workshop advertisements that highlighted activities involving visits to such spaces. The second most common motivator (76.5%) was learning more about the site's ecology. Additionally, participants (58.8%) expressed an interest in the site's future plans and environmental concerns, while some (41.2%) cited contributing to the local community as a motivating factor. Following this, all participants acknowledged a heightened appreciation for UWS through the workshops, largely attributed to the social interactions during the sessions. Furthermore, the multispecies dimension of the activities emerged as a key driver of learning and shifts in perspective (Fig. 5). The following section provides a detailed account of these results.

Social mechanisms for learning

When questioned whether they gained a deeper appreciation for these ecosystems, all participants confirmed that they had. They attributed this change largely to the social mechanisms embedded in the collaborative process, emphasizing the importance of social

Fig. 4. The four questions framing the research, structuring data analysis from surveys, interviews, and workshops, incorporating both deductive and inductive approaches.



interactions, including conversing, listening, and facilitating. Conversations during the workshops emerged as a central factor. One participant reflected, “[I] came in with a strong appreciation, but every conversation and time spent in these spaces helps me to appreciate them even more.” [W1S5]. Another highlighted how discussions with other participants enhanced their understanding: “It has been deepened by conversing about it with people who so deeply care.” [W1S1]. Similarly, another remarked, “I enjoyed discussing our experiences after the walk and learning from others what they noticed and what they are knowledgeable about.” [W1S4].

Listening was emphasized as a key component in gaining appreciation during the workshops. The structured format ensured that each participant had an opportunity to speak, fostering an environment that encouraged active listening: “Shared experience, time for observation and deep listening” [W3S3] was one participant’s response. Another participant elaborated, “And what’s really beautiful ... is giving ourselves time and the permission to do some deep listening and careful observation ... of sites that are typically underused or valued in negative ways and to... reflect on their potential and their benefits and how they integrate into the urban landscape more broadly” [W3I4]. Facilitation emerged as another significant aspect emphasized by participants. They reflected on how the facilitation process supported their learning and created a safe space for sharing and reflection. One participant noted, “It’s not a typical conversation that you have ... But to do it with intention and ... be given questions where people have to think through their thoughts and their feelings and articulate them in a group setting is rare and important and helps.” [W3I7]. Another commented on how facilitation fostered comfort and openness: “I loved the discussion. [The facilitator] does a great job at making people feel comfortable and asking good questions.” [W1S13]. This relaxed,

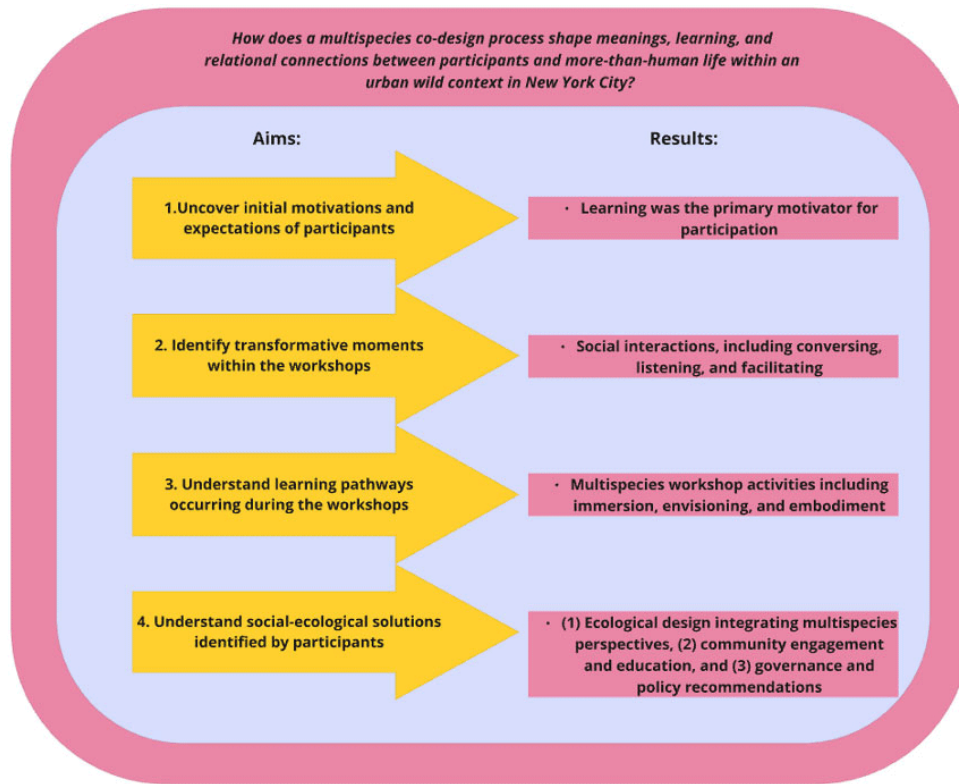
flexible approach to facilitation also resonated with the workshops’ themes. One participant observed, “I don’t think we have enough conversations about that ... It’s really nice to be brought together and ... just be led through a structured process, but also in a wild way.” [W3I4].

Immersion, envisioning and embodiment for transformation

Participants were asked to identify the specific aspects of the workshops that contributed to their learning and changed their perceptions of UWS. Their responses highlighted the significance of the workshop activities, particularly the multispecies approach and the opportunities for reflection. Regarding the multispecies approach, participants emphasized the importance of each activity within the workshops. The wild walk had a profound impact because of its immersive experience within the ecosystem. This immersion encouraged participants to focus on their sensory engagement. As one participant noted, “... it was nice to one, be in the space and have time to just focus on the space with no other interruptions, and then also to have these conversations with people from both the perspective of ... a citizen and an academic and then also existing in the space, I think [it] made me feel very connected ...” [W3I6].

The envisioning aspect of the storytelling exercise stood out as transformative for many participants. One participant reflected, “The storytelling aspect contributed the most because it pushed us into a space of fiction. I think that it creates more opportunity to engage in radical imagination and perform the worlds we want to see.” [W3S4]. This activity enabled participants to explore creative and speculative thinking, fostering a deeper engagement with UWS. Another impactful activity was the embodiment experience during the role-playing exercise. This approach placed participants in an alternate mindset and fostered empathy toward other species. One participant described its impact: “I think taking

Fig. 5. This research’s guiding questions helped identify key aspects of the co-design process, emphasizing the significance of multispecies approaches in shaping social-ecological transformations and the integral role of continuous learning throughout the process.



time to have an embodied experience with any kind of natural landscape creates a memory and a shared experience, especially with other people. The unique element that you’re bringing to the workshop is also allowing us to embody and really think about the needs of other species to take on their role, to imagine the relationships between multiple species that we often maybe consider competing, but oftentimes actually work in concert in ways we don’t know and to surface, you know, local issues, but also more broad environmental issues about how we use public spaces” [W3I4]. These activities align with transformative learning theory, enabling participants to engage with diverse perspectives and experiences, prompting them to question ingrained assumptions and adopt new ways of thinking, thereby facilitating social-ecological transformation.

Transformative solutions

Identifying challenges and solutions is central to the co-design process. Three priority action areas for social-ecological transformation were identified during this process: (1) ecological design integrating multispecies perspectives, (2) community engagement and education, and (3) governance and policy recommendations. Participants proposed alternative management strategies that respect existing site ecology, ecosystem services, and historical context while fostering stewardship. They emphasized restoring these spaces to their original wetland functions, with one suggesting conversion into a saltwater marsh for species conservation [W03]. Despite physical barriers like

fencing and fragmented management, participants envisioned a connected North Brooklyn green space, requiring collaboration between the Parks Department and local organizations. They stressed the need for respect toward both ecological systems and current management efforts, noting widespread public unawareness of the work involved in maintaining these spaces. This lack of understanding impacts appreciation and stewardship, reinforcing the need for improved public engagement [W03].

Participants consistently emphasized the pivotal role of education in fostering respect and understanding of site management and ecological value. Informing the public through signage and other educational tools was deemed crucial. For example, one participant noted, “I think education is very important ... I think people need to be educated on how each community member gets their functions in this environment and how we can take steps and measures to make sure that nobody tramples on them” [W03]. The recurrent emphasis on education across discussions was highlighted during the workshops: “There was this aspect of education just kept coming up and whether it was the QR code and walking around providing education for local people or whether it be [an] aspect of it for people to be more connected with the outdoor spaces and kept reemerging throughout all the discussions here today” [W02]. This need for increased social engagement throughout the community is reflected in the observation: “Definitely wanted to make sure that I can encourage

more people to build that like social connection across many people” [W02]. In addressing the implementation of these actions, participants identified resource allocation and policy interventions as priorities. One participant stated, “Resources always emerge, and you need resources to get these actions done” [W02]. Connections with external organizations were also considered vital for action implementation. Participants proposed collaborating with “anchor institutions” such as hospitals, schools, and libraries to secure support, particularly for urban wilding initiatives, such as those discussed during the workshops.

In practice, incorporating multispecies thinking into the co-design process shifted the focus from human-centered park use to shared habitat considerations and ecological processes. Participants were prompted to identify non-human actors such as pollinators, shoreline species, and wetland vegetation, and to consider how design and management choices could support their life cycles alongside human recreation. This shift led to proposals such as restoring salt marsh functions, limiting intensive management to allow natural succession, and designing educational signage that highlights the needs and vulnerabilities of non-human inhabitants. Instead of viewing biodiversity as an abstract goal, multispecies thinking led to site-specific recommendations that emphasize ecological functions, seasonal dynamics, and reduced human disturbance in habitats.

DISCUSSION

This research sought to understand how participation in a multispecies co-design process contributes to and supports systems transformation by using a case-study methodology in urban wild spaces (UWS) in New York City. The findings indicate that learning was the primary motivator for participation. Participants were particularly eager to learn about UWS, including their ecological dynamics and future potential. This is significant as it suggests that personal growth and curiosity, rather than duty or altruism, primarily motivate participation. Following the workshops, all participants reported a deeper appreciation for UWS, attributing it to the social learning mechanisms embedded in the process. Notably, the multispecies dimension of the activities, comprising immersion, envisioning, and embodiment, emerged as key drivers of learning and perspective shifts. The workshops produced several key outcomes for transformation in this context, categorized as (1) ecological design innovations integrating multispecies perspectives, (2) enhanced community engagement and education, and (3) governance and policy recommendations. The following discussion examines how the co-design process in this context catalyzed social-ecological transformation and explores its broader implications and guiding principles for facilitating co-design in similar contexts.

Learning as a key component

Understanding how to connect with people is a crucial first step in encouraging individuals to participate in collaborative processes, particularly during communication with potential collaborators (Mintzberg et al. 1996). For several reasons, understanding what motivates participants to join the co-design process is essential. Motivation directly influences the level and quality of participants’ engagement. When participants are intrinsically motivated, such as by a desire to learn, as in this case,

they are more likely to engage actively in discussions, contribute innovative ideas, and collaborate effectively with others (Delaney and Royal 2017). This active participation enriches the co-design process and enhances its outcomes. Additionally, identifying motivations helps researchers and facilitators design processes that align with participants’ interests and needs. Tailoring activities to leverage these motivations may increase participant satisfaction and foster a sense of ownership over the process, both of which are critical to the long-term success and implementation of co-designed solutions. For instance, incorporating educational elements or opportunities for expert knowledge-sharing into the process may amplify its impact.

Furthermore, understanding motivations offers insights into the broader social and cultural factors that influence participation in collaborative initiatives. These insights are crucial for developing inclusive and equitable processes that address barriers to participation and ensure that diverse voices and perspectives are represented. Additionally, motivations are closely linked to transformative outcomes. In SES, transformation often necessitates a shift in values, perspectives, and behaviors (Pelling et al. 2015, Horcea-Milcu et al. 2019, Voulvoulis et al. 2022). By understanding participants’ initial motivations, researchers can better assess how the co-design process fosters these shifts and contributes to broader systemic change. Uncovering participant motivations is integral to designing effective, inclusive, and transformative co-design processes, ultimately supporting their potential to drive meaningful social and ecological change.

In multispecies co-design, recognizing how learning and motivation evolve is crucial for fostering meaningful interactions between humans and the ecological systems they inhabit. By integrating co-design methods into both mandatory and voluntary engagement strategies, land managers and governance actors can cultivate participatory, adaptive stewardship practices. A variety of engagement strategies can facilitate this integration. Low-resource approaches, such as hosting community workshops and webinars, provide accessible entry points for participation and knowledge exchange. These initiatives enable participants to share experiences, identify common values, and develop an understanding of how human actions intersect with multispecies habitats. Medium-resource strategies, including citizen science programs, seasonal monitoring projects, and participatory mapping, encourage long-term involvement by fostering deeper connections between communities and UWS. For a more transformative impact, high-resource initiatives such as long-term community planning, visioning workshops, and ecological restoration co-design projects can drive systemic change. These efforts demand sustained commitment but offer the potential to reshape governance structures and cultivate enduring stewardship networks. Ultimately, aligning learning and motivation with diverse participation opportunities ensures that collaborative initiatives remain equitable, adaptive, and capable of fostering social and ecological resilience.

Social-ecological transformations: a complex process

Social-ecological transformations involve complex, dynamic changes that lead to shifts in the form or function of systems, whether positively or negatively (Andrachuk and Armitage 2015). Social learning is a critical driver of these transformations, as it encourages changes in worldviews, values, and perspectives

through critical reflection and dialogue (Mezirow 1997). In this study, key social mechanisms embedded in the co-design process supported this learning, including active dialogue and mutual listening among participants. The facilitation of these mechanisms was crucial. As a means of bridging epistemological and ontological divides, listening is identified as essential for promoting interdisciplinary and transdisciplinary collaboration (Branny et al. 2025). Participants frequently attributed their new appreciation of UWS to insights gained through conversations and feedback from others.

They also stressed the pivotal role of facilitation in creating a supportive and inclusive environment. Facilitators ensured that participants felt comfortable expressing themselves openly, underscoring the importance of trust in collaborative endeavors. Although trust is often recognized as significant during pre-engagement (Glackin and Dionisio 2016), this study emphasizes the need to build trust throughout the process. Effective facilitation entails clear communication, engagement, and interaction among participants to foster an open, non-judgmental environment (Schwarz et al. 2011, Emke et al. 2024). The clarity in facilitator-participant communication is particularly essential, as its absence may jeopardize the success of collaborative efforts (Eckert et al. 2003, Mackenzie et al. 2012). Whereas its presence promotes unfiltered dialogue and accelerates decision-making (Lencioni 2010).

Integrating a multispecies perspective into co-design

The co-design process in this study adopts a multispecies approach, embedding multispecies thinking into all workshop activities. This approach emphasizes the need to consider the interactions and needs of both human and non-human life forms. A fitting example of geographies that extend beyond humans within New York City is Freshkills Park (<https://freshkillspark.org>), where a former landfill has been transformed into an ecosystem in which both human and non-human life flourish. The park's design prioritizes ecological restoration, enabling wildlife to recolonize while incorporating sustainable infrastructure and recreational spaces that harmonize with natural processes rather than overpowering them.

Roudavski (2020) advocates for engaging non-human life forms as collaborators to promote multispecies cohabitation, a vital strategy for addressing planetary crises. One such approach is “multispecies worldlings” (Westerlaken 2020), a process of paying attention to other species' world-making, which is a useful frame when engaging with processes such as design. Achieving meaningful urban transformations requires abandoning anthropocentric biases in design and governance and extending emancipatory efforts to include non-human collaborators. The multispecies approach profoundly influenced participants in this case study, leading to transformative shifts in their perceptions of UWS. The participants identified the multispecies focus of the activities, namely immersion, envisioning, and embodiment, as the key contributors to perceptual shifts. These activities foster deeper connections with the surrounding environments and their inhabitants, and build empathy toward other species. When people feel such empathy, they tend to care more about environmental issues such as climate change (Pahl and Bauer 2013). Therefore, employing methods in social-ecological research and practice that encourage empathy is increasingly necessary.

Embedding multispecies approaches in SES is also vital for sustainable land management. Conventional urban green space management often treats nature as a resource, failing to account for the interdependent needs of humans and other species (Rupprecht et al. 2020). A multispecies perspective can inform policies that positively impact ecological systems and enhance urban biodiversity. O'Donnell et al. (2026) demonstrate that the co-design process conducted in this research, when applied in other contexts, produces transformative shifts in participants' narratives about managing urban green spaces, moving from control and dominion to care and stewardship. Although participants play a crucial role in the collaborative process, particularly by contributing their knowledge and perceptions, the argument against using the term “stakeholder” is also growing, as it can perpetuate systemic inequalities (Reed et al. 2024). This presents a unique opportunity to focus on alternative actors, encompassing a broad range of people, places, and species, to encourage more inclusive and equitable collaboration for a sustainable future. Delving deeper into the concept of diversity within these processes and exploring ways to broaden their scope involves reevaluating the language and frameworks used to ensure inclusivity, ensuring that all participants' diverse viewpoints and contributions are represented and considered. Through co-designing with this non-human component, we may initiate a novel form of ecological restoration within our SES.

Integrating multispecies thinking into our co-design approaches within SES allows us to reshape dominant thought patterns and attempt to reverse some of the environmental destruction we've caused while respecting the non-human species embedded in these systems' transformation pathways. This study argues that integrating multispecies approaches into co-design practices is essential for fostering sustainable societies. We can design more equitable and ecologically resilient systems by acknowledging and addressing the complex, interdependent needs of humans and other species. Based on this argument and the findings in this research paper, a set of guiding principles for implementing a multispecies co-design approach has been developed.

Guiding principles for social-ecological transformation

The research findings provide insight into three key guideline areas for planning and designing a multispecies co-design process for social-ecological transformation:

- (1) Multispecies co-design processes should be structured to prioritize and facilitate learning, responding to participants' interests in acquiring knowledge about ecological systems, collaborative methods, and other relevant topics while ensuring that learning focuses on both human and non-human needs and interests. One approach to achieving this in a multispecies co-design process may be through a community-based project similar to the Bronx River Restoration Project, which fosters partnerships among communities, ecologists, and agencies to integrate educational programs and restoration efforts that benefit humans and non-human species.
- (2) Collaborative processes must prioritize and design for active social participation, including structured opportunities for dialogue, attentive listening, and thoughtful facilitation within SES. To ensure inclusivity, targeted outreach should be employed to engage a diverse range of participants. These interactions allow individuals from varied backgrounds to exchange perspectives, build mutual understanding, and collectively deepen their

appreciation and empathy for ecosystems and non-human species. This diversity ultimately enhances the co-design process's transformative potential, fostering richer, more inclusive solutions.

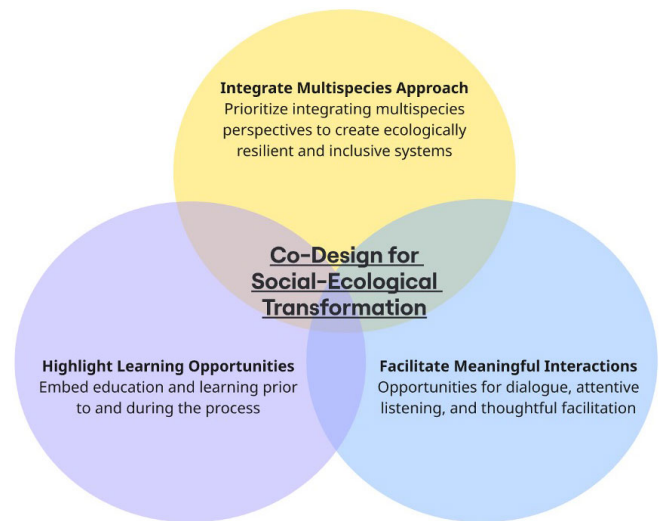
(3) Design processes should purposefully include activities that prompt participants to engage with and contemplate multispecies perspectives, encompassing non-human species' interests, needs, and agencies, similar to the workshop activities utilized in this research. Embedding reflection within these activities allows participants to process and internalize their experiences, fostering deeper connections and transformative insights into the interconnectedness of SES. Addressing the interdependent needs of human and non-human species requires embedding these considerations into design principles and practices that support social-ecological transformations.

The principles of learning, interaction, and a multispecies approach offer a flexible framework for addressing urban challenges (Fig. 6). Instead of prescribing solutions, they promote inclusive processes and strategies grounded in care. These principles may enhance decision making and support community-led initiatives in urban areas. Communities can be encouraged to engage in ecosystem stewardship by reframing ecological challenges as learning opportunities. During the process, meaningful interactions among diverse actors, such as residents, policy makers, and ecologists, may bridge knowledge gaps and foster deeper collaboration in urban design.

In cases like New York City, where competing interests range from conservation to recreation to land development, co-design processes help navigate these tensions by encouraging dialogue and collaboration among diverse actors. Rather than imposing top-down solutions, planners may create multifunctional spaces that balance ecological integrity with human needs by involving community members in shaping access policies, infrastructure design, and habitat restoration. Incorporating a multispecies approach enables the development of more nuanced, ecologically informed strategies for urban resilience. Instead of viewing urban nature as merely a backdrop to human activity or a blockage, this perspective acknowledges the role of non-human species in shaping resilient ecosystems. For example, integrating pollinator-friendly vegetation, designing shoreline buffers that support aquatic biodiversity, and allowing for controlled natural succession in parks may lead to adaptive landscapes that require less intensive management while preserving ecological benefits. Allowing controlled natural succession in parks can also decrease maintenance demands while fostering dynamic landscapes that evolve with environmental conditions (Dunnett and Hitchmough 2004). Urban spaces may better withstand climate pressures and ecological disturbances further by moving away from rigid, one-size-fits-all solutions toward dynamic, site-responsive strategies.

Beyond ecological benefits, such approaches also encourage social resilience. Ultimately, these principles provide a pathway for transforming urban design and management practices. By addressing systemic challenges through such approaches, cities may advance toward more just, resilient, and ecologically integrated spaces. Their flexibility ensures they remain relevant across diverse urban contexts, guiding the development of policies and projects that reflect the complex, interdependent nature of urban ecosystems. By acknowledging nature's role in urban

Fig. 6. Multispecies co-design for social-ecological transformation incorporates three priority action areas.



resilience and ensuring broad community participation, cities may transition from static, high-maintenance designs toward living landscapes that adapt to environmental and social needs.

Although the immediate outputs of the co-design process in this study are delivered as recommendations, presented as Urban Wilding Guidelines to the North Brooklyn Parks Alliance, these should be viewed as part of an ongoing transformative effort rather than final products. The guidelines have been officially shared with the collaborators to guide advocacy and discussions with municipal authorities. Because ecological restoration, policy change, and infrastructure projects take considerable time, it is currently impossible to evaluate the site's complete material transformation. Nevertheless, the co-designed guidelines serve as a strategic intervention, translating collective knowledge, values, and multispecies concerns into a practical pathway that influences decision making and has the potential to foster long-term social-ecological change along the Greenpoint-Williamsburg waterfront. Although the co-design process in this research offers valuable insights, several limitations must be acknowledged; these are available in Appendix 1.

CONCLUSION

This research investigates how a co-design process incorporating a multispecies approach may support social-ecological transformation, focusing on a case study along the North Brooklyn waterfront in New York City. Three co-design workshops were conducted alongside surveys and interviews, and the data were analyzed thematically to explore how the process may facilitate social-ecological transformation.

The findings reveal that participants were motivated to join the co-design process to learn about urban wild spaces (UWS), their ecological dynamics, and potential future opportunities for these sites. Participants developed a newfound appreciation for UWS, largely attributed to the social interactions facilitated during the workshops. Moreover, integrating multispecies perspectives was

a critical driver of learning and perceptual changes. Three social-ecological transformative solutions were identified: ecological design principles incorporating multispecies considerations, community engagement and education, and governance and policy recommendations.

Reflections on the process and its findings resulted in the development of heuristic principles to effectively support social-ecological transformations: highlighting learning opportunities to attract and engage participants, facilitating meaningful interactions to enable diverse perspectives and build mutual understanding, and intentionally integrating multispecies perspectives while embedding reflection to deepen participants' connections and insights into the interconnectedness of social-ecological systems. These principles provide a scalable, adaptable framework for addressing urban ecological challenges, demonstrating that participatory learning, meaningful collaboration, and multispecies integration are not merely theoretical ideals but practical strategies for fostering resilient, inclusive, and ecologically responsive cities. This research underscores the importance of incorporating a multispecies approach in co-design processes to enhance understanding of complex systems and foster meaningful social-ecological transformations.

Author Contributions:

MOD: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Supervision; Validation; Writing - original draft; Writing - review & editing

MPP: Formal analysis; Data curation; Supervision; Validation; Writing - review & editing

CK: Formal analysis; Data curation; Supervision; Validation; Writing - review & editing

TM: Formal analysis; Data curation; Supervision; Validation; Writing - review & editing

MC: Formal analysis; Data curation; Supervision; Validation; Writing - review & editing

LB: Formal analysis; Data curation; Supervision; Validation; Writing - review & editing

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Data Availability:

The authors confirm that the data supporting this study's findings are available within the article or its supplementary materials.

LITERATURE CITED

- Ahern, J., S. Cilliers, and J. Niemelä. 2014. The concept of ecosystem services in adaptive urban planning and design: a framework for supporting innovation. *Landscape and Urban Planning* 125:254-259. <https://doi.org/10.1016/j.landurbplan.2014.01.020>
- Andrachuk, M., and D. Armitage. 2015. Understanding social-ecological change and transformation through community perceptions of system identity. *Ecology and Society* 20(4):26. <https://doi.org/10.5751/ES-07759-200426>
- Armitage, D., S. Alexander, M. Andrachuk, S. Berdej, T. Dyck, P. K. Nayak, J. Pittman, and K. Rathwell. 2015. Emerging concepts in adaptive management. Pages 235-254 in C. R. Allen and A. S. Garmestani, editors. *Adaptive management of social-ecological systems*. Springer, Dordrecht, The Netherlands. https://doi.org/10.1007/978-94-017-9682-8_13
- Arnstein, S. R. 1969. A ladder of citizen participation. *Journal of the American Institute of Planners* 35(4):216-224. <https://doi.org/10.1080/01944366908977225>
- Asah, S. T., and D. J. Blahna. 2020. Involving stakeholders' knowledge in co-designing social valuations of biodiversity and ecosystem services: implications for decision-making. *Ecosystems* 23(2):324-337. <https://doi.org/10.1007/s10021-019-00405-6>
- Azadi, H., P. Ho, E. Hafni, K. Zarafshani, and F. Witlox. 2011. Multi-stakeholder involvement and urban green space performance. *Journal of Environmental Planning and Management* 54(6):785-811. <https://doi.org/10.1080/09640568.2010.530513>
- Balvanera, P., R. Calderón-Contreras, A. J. Castro, M. R. Felipe-Lucia, I. R. Geijzenborffer, S. Jacobs, B. Martín-López, U. Arbieu, C. I. Speranza, B. Locatelli, N. P. Harguindeguy, I. R. Mercado, M. J. Spierenburg, A. Vallet, L. Lynes, and L. Gillson. 2017. Interconnected place-based social-ecological research can inform global sustainability. *Current Opinion in Environmental Sustainability* 29:1-7. <https://doi.org/10.1016/j.cosust.2017.09.005>
- Berkes, F., C. Folke, and J. Colding. 2000. *Linking social and ecological systems: management practices and social mechanisms for building resilience*. Cambridge University Press, Cambridge, UK.
- Bianchini, M., F. Inzani, J. Verlinden, and S. De Ridder. 2023. Designing with post-human kinship. Outlining new human non-human collaborative approaches. Pages 582-585 in K. Vaes and J. C. Verlinden, editors. *Connectivity and creativity in times of conflicts*. Academia, Gent, Belgium.
- Biggs, H. R., J. Bardzell, and S. Bardzell. 2021. Watching myself watching birds: abjection, ecological thinking, and posthuman design. Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems. <https://doi.org/10.1145/3411764.3445329>
- Bisht, V., R. Carrillo, M. Franco, V. Angeles-Wann, J.-B. Rosales Chavez, S. Gomez, J. Hess, A. Kuhn, P. Mollen, J. Morales-Guerrero, J. Wann-Ángeles, C. Cheng, and M. Berbés-Blázquez. 2025. Enabling "barrio" innovation: a grassroots approach for centering community initiatives in just sustainability transformations. *Ecology and Society* 30(1):8. <https://doi.org/10.5751/ES-15749-300108>

- Bonthoux, S., and S. Chollet. 2024. Wilding cities for biodiversity and people: a transdisciplinary framework. *Biological Reviews* 99(4):1458-1480. <https://doi.org/10.1111/brv.13076>
- Branny, A., M. Maurer, E. Andersson, T. McPhearson, C. M. Raymond, M. Faehnle, A. S. Olafsson, and N. M. Gulrud. 2025. Introducing listening as a weak method for advancing sustainability and interdisciplinary scholarship. *Sustainability Science* 20(1):77-94. <https://doi.org/10.1007/s11625-024-01571-w>
- Braun, V., and V. Clarke. 2006. Using thematic analysis in psychology. *Qualitative Research in Psychology* 3(2):77-101. <https://doi.org/10.1191/1478088706qp063oa>
- Buckton, S. J., I. Fazey, B. Sharpe, E. S. Om, B. Doherty, P. Ball, K. Denby, M. Bryant, R. Lait, S. Bridle, M. Cain, E. Carmen, L. Collins, N. Nixon, C. Yap, A. Connolly, B. Fletcher, A. Frankowska, G. Gardner, A. James, I. Kendrick, A. Kluczkovski, S. Mair, B. Morris, and M. Sinclair. 2023. The regenerative lens: a conceptual framework for regenerative social-ecological systems. *One Earth* 6(7):824-842. <https://doi.org/10.1016/j.oneear.2023.06.006>
- Buijs, A. E., T. J. M. Mattijssen, A. P. N. Van der Jagt, B. Ambrose-Oji, E. Andersson, B. H. M. Elands, and M. Steen Møller. 2016. Active citizenship for urban green infrastructure: fostering the diversity and dynamics of citizen contributions through mosaic governance. *Current Opinion in Environmental Sustainability* 22:1-6. <https://doi.org/10.1016/j.cosust.2017.01.002>
- Bulkeley, H. 2013. *Cities and climate change*. Routledge, London, UK. <https://doi.org/10.4324/9780203077207>
- Cantrell, B., L. J. Martin, and E. C. Ellis. 2017. Designing autonomy: opportunities for new wildness in the Anthropocene. *Trends in Ecology & Evolution* 32(3):156-166. <https://doi.org/10.1016/j.tree.2016.12.004>
- Chapin, III, F. S., S. R. Carpenter, G. P. Kofinas, C. Folke, N. Abel, W. C. Clark, P. Olsson, D. M. S. Smith, B. Walker, O. R. Young, et al. 2010. Ecosystem stewardship: sustainability strategies for a rapidly changing planet. *Trends in Ecology & Evolution* 25(4):241-249. <https://doi.org/10.1016/j.tree.2009.10.008>
- Clark, W. C. 2007. Sustainability science: a room of its own. *Proceedings of the National Academy of Sciences of the United States of America* 104(6):1737-1738. <https://doi.org/10.1073/pnas.0611291104>
- Clarke, V., V. Braun, and N. Hayfield. 2015. Thematic analysis. Pages 222-248 in J. A. Smith, editor. *Qualitative psychology: a practical guide to research methods*. SAGE, London, UK.
- Colding, J., and S. Barthel. 2019. Exploring the social-ecological systems discourse 20 years later. *Ecology and Society* 24(1):2. <https://doi.org/10.5751/ES-10598-240102>
- Colding, J., and C. Folke. 2001. Social taboos: "invisible" systems of local resource management and biological conservation. *Ecological Applications* 11(2):584-600. [https://doi.org/10.1890/1051-0761\(2001\)011\[0584:STISOL\]2.0.CO;2](https://doi.org/10.1890/1051-0761(2001)011[0584:STISOL]2.0.CO;2)
- Costanza, R. 2014. A theory of socio-ecological system change. *Journal of Bioeconomics* 16(1):39-44. <https://doi.org/10.1007/s10818-013-9165-5>
- Csomós, G., J. Z. Farkas, and Z. Kovács. 2020. Access to urban green spaces and environmental inequality in post-socialist cities. *Hungarian Geographical Bulletin* 69(2):191-207. <https://doi.org/10.15201/hungeobull.69.2.7>
- de La Bellacasa, M. P. 2017. *Matters of care: speculative ethics in more than human worlds*. University of Minnesota Press, Minneapolis, Minneapolis, USA.
- Delaney, M. L., and M. A. Royal. 2017. Breaking engagement apart: the role of intrinsic and extrinsic motivation in engagement strategies. *Industrial and Organizational Psychology* 10(1):127-140. <https://doi.org/10.1017/iop.2017.2>
- Dennis, W. 2025. *History of Bushwick Inlet Park*. Friends of Bushwick Inlet Park, New York, USA. <https://bushwickinletpark.org/history/>
- Dolejšová, M., S. v. Gaalen, D. Wilde, P. G. Raven, S. Heitlinger, and A. Light. 2020. Designing with more-than-human food practices for climate-resilience. *DIS'20 Companion: Companion Publication of the 2020 ACM Designing Interactive Systems Conference*. Association for Computing Machinery, Eindhoven, The Netherlands. <https://doi.org/10.1145/3393914.3395909>
- Dressler, W., B. BÜscher, M. Schoon, D. A. N. Brockington, T. Hayes, C. A. Kull, J. McCarthy, and K. Shrestha. 2010. From hope to crisis and back again? A critical history of the global CBNRM narrative. *Environmental Conservation* 37(1):5-15. <https://doi.org/10.1017/S0376892910000044>
- Dunnett, N., and J. Hitchmough, editors. 2004. *The dynamic landscape: design, ecology and management of naturalistic urban planting*. Routledge, London, UK. <https://doi.org/10.4324/9780429283338>
- Eckert, C., M. Stacey, and C. Earl. 2003. Ambiguity is a double-edged sword: similarity references in communication. Paper presented at: Proceedings of the 14th international conference on engineering design. <https://oro.open.ac.uk/13228/>
- Elmqvist, T., M. Fragkias, J. Goodness, B. Güneralp, P. J. Marcotullio, R. I. McDonald, S. Parnell, M. Schewenius, M. Sendstad, K. C. Seto, and C. Wilkinson. 2013. Urbanization, biodiversity and ecosystem services: challenges and opportunities: a global assessment. *Springer Nature*, Dordrecht, The Netherlands. <https://doi.org/10.1007/978-94-007-7088-1>
- Emke, H., A. Vandendriessche, M. Chinapaw, B. Deforche, M. Verloigne, T. Altenburg, and M. Anselma. 2024. Facilitating co-research: lessons learned from reflection forms within three participatory action research projects. *Health Research Policy and Systems* 22(1):117. <https://doi.org/10.1186/s12961-024-01210-x>
- Ernstson, H. 2013. The social production of ecosystem services: a framework for studying environmental justice and ecological complexity in urbanized landscapes. *Landscape and Urban Planning* 109(1):7-17. <https://doi.org/10.1016/j.landurbplan.2012.10.005>
- Fieuw, W., M. Foth, and G. A. Caldwell. 2022. Towards a more-than-human approach to smart and sustainable urban development: designing for multispecies justice. *Sustainability* 14(2):948. <https://doi.org/10.3390/su14020948>

- Fleck, J. 2016. Water is for fighting over: and other myths about water in the west. Island, Washington, D.C., USA. <https://doi.org/10.2307/jj.40831441>
- Folke, C., S. R. Carpenter, B. Walker, M. Scheffer, T. Chapin, and J. Rockström. 2010. Resilience thinking: integrating resilience, adaptability and transformability. *Ecology and Society* 15(4):20. <https://doi.org/10.5751/ES-03610-150420>
- Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social-ecological systems. *Annual Review of Environment and Resources* 30:441-473. <https://doi.org/10.1146/annurev.energy.30.050504.144511>
- Forlano, L. 2017. Posthumanism and design. *She Ji: The Journal of Design, Economics, and Innovation* 3(1):16-29. <https://doi.org/10.1016/j.sheji.2017.08.001>
- Francis, R. A., and M. A. Chadwick. 2013. *Urban ecosystems: understanding the human environment*. Routledge, London, UK. <https://doi.org/10.4324/9780203133644>
- Frantzeskaki, N., N. Kabisch, and T. McPhearson. 2016. Advancing urban environmental governance: understanding theories, practices and processes shaping urban sustainability and resilience. *Environmental Science and Policy* 62:1-6. <https://doi.org/10.1016/j.envsci.2016.05.008>
- Frantzeskaki, N., and A. Rok. 2018. Co-producing urban sustainability transitions knowledge with community, policy and science. *Environmental Innovation and Societal Transitions* 29:47-51. <https://doi.org/10.1016/j.eist.2018.08.001>
- Friesen, S., and D. Scott. 2013. *Inquiry-based learning: a review of the research literature*. Alberta Ministry of Education, Edmonton, Alberta, Canada.
- Gandy, M. 2016. Unintentional landscapes. *Landscape Research* 41(4):433-440. <https://doi.org/10.1080/01426397.2016.1156069>
- Glackin, S., and M. R. Dionisio. 2016. 'Deep engagement' and urban regeneration: tea, trust, and the quest for co-design at precinct scale. *Land Use Policy* 52:363-373. <https://doi.org/10.1016/j.landusepol.2016.01.001>
- Gonsalves, K., A. Aia-Fa'aleava, L. Thanh Ha, N. Junpiban, N. Narain, M. Foth, and G. A. Caldwell. 2023. Transhuman saunter: multispecies storytelling in precarious times. *Leonardo* 56(2):125-132. https://doi.org/10.1162/leon_a_02243
- González-Duarte, C., and R. Méndez-Arreola. 2024. "Living in the time of the butterfly:" engaging more-than-human temporalities to rethink biodiversity conservation. *Journal of Political Ecology* 31(1):217-233. <https://doi.org/10.2458/jpe.5015>
- Groutars, E. G., R. Kim, and E. Karana. 2024. Designing living artefacts for multispecies interactions: an ecological approach. *International Journal of Design* 18(2):59-78.
- Haase, D., N. Larondelle, E. Andersson, M. Artmann, S. Borgström, J. Breuste, E. Gomez-Baggethun, Å. Gren, Z. Hamstead, R. Hansen, N. Kabisch, P. Kremer, J. Langemeyer, E. L. Rall, T. McPhearson, S. Pauleit, S. Qureshi, N. Schwarz, A. Voigt, D. Wurster, and T. Elmqvist. 2014. A quantitative review of urban ecosystem service assessments: concepts, models, and implementation. *Ambio* 43(4):413-433. <https://doi.org/10.1007/s13280-014-0504-0>
- Haraway, D. 2023. When species meet. Pages 42-78 in A. Franklin, editor. *The Routledge international handbook of more-than-human studies*. Routledge, London, UK. <https://doi.org/10.4324/9781003262619-4>
- Hester Street. 2024. Hester street will sunset after 20 years. Hester Street, New York, New York, USA. <https://hesterstreet.org/hester-street-will-sunset-after-20-years/>
- Hilborn, R., R. O. Amoroso, C. M. Anderson, J. K. Baum, T. A. Branch, C. Costello, C. L. De Moor, A. Faraj, D. Hively, O. P. Jensen, et al. 2020. Effective fisheries management instrumental in improving fish stock status. *Proceedings of the National Academy of Sciences* 117(4):2218-2224. <https://doi.org/10.1073/pnas.1909726116>
- Hinchliffe, S., and S. Whatmore. 2006. Living cities: towards a politics of conviviality. *Science as Culture* 15(2):123-138. <https://doi.org/10.1080/09505430600707988>
- Holmes, A. G. D. 2020. Researcher positionality—a consideration of its influence and place in qualitative research—a new researcher guide. *Shanlax International Journal of Education* 8(4):1-10. <https://doi.org/10.34293/education.v8i4.3232>
- Horcea-Milcu, A.-I., D. J. Abson, C. I. Apetrei, I. A. Duse, R. Freeth, M. Riechers, D. P. M. Lam, C. Dorninger, and D. J. Lang. 2019. Values in transformational sustainability science: four perspectives for change. *Sustainability Science* 14(5):1425-1437. <https://doi.org/10.1007/s11625-019-00656-1>
- Houston, D., J. Hillier, D. MacCallum, W. Steele, and J. Byrne. 2018. Make kin, not cities! Multispecies entanglements and 'becoming-world' in planning theory. *Planning Theory* 17(2):190-212. <https://doi.org/10.1177/1473095216688042>
- Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). 2019. *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. E. S. Brondizio, J. Settele, S. Diaz, and H. T. Ngo, editors. IPBES Secretariat, Bonn, Germany.
- Jorgensen, A., and M. Tylecote. 2007. Ambivalent landscapes—wilderness in the urban interstices. *Landscape Research* 32(4):443-462. <https://doi.org/10.1080/01426390701449802>
- Jørgensen, D. 2015. Rethinking rewilding. *Geoforum* 65:482-488. <https://doi.org/10.1016/j.geoforum.2014.11.016>
- Kabisch, N., N. Frantzeskaki, S. Pauleit, S. Naumann, M. Davis, M. Artmann, D. Haase, S. Knapp, H. Korn, J. Stadler, K. Zaunberger, and A. Bonn. 2016. Nature-based solutions to climate change mitigation and adaptation in urban areas: perspectives on indicators, knowledge gaps, barriers, and opportunities for action. *Ecology and Society* 21(2):39. <https://doi.org/10.5751/ES-08373-210239>
- Kabisch, N., S. Qureshi, and D. Haase. 2015. Human-environment interactions in urban green spaces—a systematic

- review of contemporary issues and prospects for future research. *Environmental Impact Assessment Review* 50:25-34. <https://doi.org/10.1016/j.eiar.2014.08.007>
- Kennedy, C. 2022. Ruderal resilience: applying a ruderal lens to advance multispecies urbanism and social-ecological systems theory. *Frontiers in Built Environment* 8:769357. <https://doi.org/10.3389/fbuil.2022.769357>
- Kirksey, E. 2014. *The multispecies salon*. Duke University Press, Durham, North Carolina, USA. <https://doi.org/10.1515/9780822376989>
- Kirksey, S. E., and S. Helmreich. 2010. The emergence of multispecies ethnography. *Cultural Anthropology* 25(4):545-576. <https://doi.org/10.1111/j.1548-1360.2010.01069.x>
- Kowarik, I. 2018. Urban wilderness: supply, demand, and access. *Urban Forestry & Urban Greening* 29:336-347. <https://doi.org/10.1016/j.ufug.2017.05.017>
- Leal Filho, W., L. Caughman, M. A. Pimenta Dinis, F. Frankenberger, A. M. Azul, and A. L. Salvia. 2022. Towards symbiotic approaches between universities, sustainable development, and cities. *Scientific Reports* 12(1):11433. <https://doi.org/10.1038/s41598-022-15717-2>
- Lencioni, P. M. 2010. *The five dysfunctions of a team: a leadership fable*. John Wiley & Sons, Hoboken, New Jersey, USA.
- Locke, P., and U. Muenster. 2015. *Multispecies ethnography*. Oxford University Press, Oxford, UK. <https://doi.org/10.1093/obo/9780199766567-0130>
- Lorimer, J. 2012. Multinatural geographies for the Anthropocene. *Progress in Human Geography* 36(5):593-612. <https://doi.org/10.1177/0309132511435352>
- Mackenzie, J., P.-L. Tan, S. Hoverman, and C. Baldwin. 2012. The value and limitations of participatory action research methodology. *Journal of Hydrology* 474:11-21. <https://doi.org/10.1016/j.jhydrol.2012.09.008>
- Marris, E. 2013. *Rambunctious garden: saving nature in a post-wild world*. Bloomsbury, London, UK.
- McKinney, M. L. 2002. Urbanization, biodiversity, and conservation: the impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. *BioScience* 52(10):883-890. [https://doi.org/10.1641/0006-3568\(2002\)052\[0883:UBAC\]2.0.CO;2](https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2)
- McPhearson, T., C. M. Raymond, N. Gulsrud, C. Albert, N. Coles, N. Fagerholm, M. Nagatsu, A. S. Olafsson, N. Soininen, and K. Vierikko. 2021. Radical changes are needed for transformations to a good Anthropocene. *npj Urban Sustainability* 1(1):5. <https://doi.org/10.1038/s42949-021-00017-x>
- Melles, G. 2021. Participatory co-design for sustainable development. Pages 839-849 in W. Leal Filho, A. M. Azul, L. Brandli, A. Lange Salvia, and T. Wall, editors. *Partnerships for the Goals*. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-95963-4_47
- Merrie, A., and P. Olsson. 2014. An innovation and agency perspective on the emergence and spread of marine spatial planning. *Marine Policy* 44:366-374. <https://doi.org/10.1016/j.marpol.2013.10.006>
- Metzger, J. 2015. Expanding the subject of planning: enacting the relational complexities of more-than-human urban common(er)s. Pages 133-149 in S. Kirwan, L. Dawney, and J. Brigstocke, editors. *Space, power and the commons*. Routledge, London, UK.
- Mezirow, J. 1997. Transformative learning: theory to practice. *New Directions for Adult and Continuing Education* 1997(74):5-12. <https://doi.org/10.1002/ace.7401>
- Miller, T. R., A. Wiek, D. Sarewitz, J. Robinson, L. Olsson, D. Kriebel, and D. Loorbach. 2014. The future of sustainability science: a solutions-oriented research agenda. *Sustainability Science* 9(2):239-246. <https://doi.org/10.1007/s11625-013-0224-6>
- Mintzberg, H., J. Jorgensen, D. Dougherty, and F. Westley. 1996. Some surprising things about collaboration-knowing how people connect makes it work better. *Organizational Dynamics* 25(1):60-71. [https://doi.org/10.1016/S0090-2616\(96\)90041-8](https://doi.org/10.1016/S0090-2616(96)90041-8)
- Monroe, M. C. 2002. Evaluation s friendly voice: the structured open-ended interview. *Applied Environmental Education and Communication* 1(2):101-106. <https://doi.org/10.1080/15330150213993>
- Morton, T. 2016. *Dark ecology*. Columbia University Press, New York, New York, USA. <https://doi.org/10.7312/mort17752>
- Moser, S. C. 2016. Can science on transformation transform science? Lessons from co-design. *Current Opinion in Environmental Sustainability* 20:106-115. <https://doi.org/10.1016/j.cosust.2016.10.007>
- Murphy, M. A., P. Parker, and M. Hermus. 2023. Cultivating inclusive public space with urban gardens. *Local Environment* 28(1):99-116. <https://doi.org/10.1080/13549839.2022.2120461>
- Nguyen, N. T., A. Collins, and C. M. Collins. 2024. Trends and patterns in the application of co-production, co-creation, and co-design methods in studies of green spaces: a systematic review. *Environmental Science & Policy* 152:103642. <https://doi.org/10.1016/j.envsci.2023.103642>
- Nijs, G., G. Laki, R. Houlstan, G. Slizewicz, and T. Laureyssens. 2020. Fostering more-than-human imaginaries: introducing DIY speculative fabulation in Civic HCI. *NordiCHI '20: Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society*. <https://doi.org/10.1145/3419249.3420147>
- NYS Department of Environmental Conservation. 2026. *DER environmental remediation databases*. NYS Department of Environmental Conservation, New York, New York, USA. <https://appfactory.dec.ny.gov/DERExternalSearch/ERDDetails?CameFromList=false&SiteCode=224055A>
- O'Donnell, E. C., J. E. Lamond, and C. R. Thorne. 2017. Recognising barriers to implementation of blue-green infrastructure: a Newcastle case study. *Urban Water Journal* 14(9):964-971. <https://doi.org/10.1080/1573062X.2017.1279190>

- O'Donnell, M. 2025. Future novel ecologies: exploring multispecies futures in urban places through a co-design workshop. *Urban Ecosystems* 28(6):234. <https://doi.org/10.1007/s11252-025-01846-9>
- O'Donnell, M., M. Collier, M. Pineda-Pinto, C. Cooper, F. Nulty, and N. R. Castañeda. 2025. Redefining co-design for social-ecological research and practice: a systematic literature review. *Environmental Science & Policy* 164:103998. <https://doi.org/10.1016/j.envsci.2025.103998>
- O'Donnell, M., M. Pineda-Pinto, E. Andersson, and M. Collier. 2026. From control to cohabitation: social-ecological insights on urban wildness narratives. *Urban Forestry & Urban Greening* 117:129279. <https://doi.org/10.1016/j.ufug.2026.129279>
- Olsson, P., Ö. Bodin, and C. Folke. 2010. Building transformative capacity for ecosystem stewardship in social-ecological systems. Pages 263-285 in D. Armitage and R. Plummer, editors. *Adaptive capacity and environmental governance*. Springer, Berlin, Germany. https://doi.org/10.1007/978-3-642-12194-4_13
- Olsson, P., L. H. Gunderson, S. R. Carpenter, P. Ryan, L. Lebel, C. Folke, and C. S. Holling. 2006. Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. *Ecology and Society* 11(1):18. <https://doi.org/10.5751/ES-01595-110118>
- Pahl, S., and J. Bauer. 2013. Overcoming the distance: perspective taking with future humans improves environmental engagement. *Environment and Behavior* 45(2):155-169. <https://doi.org/10.1177/0013916511417618>
- Pahl-Wostl, C. 2009. A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change* 19 (3):354-365. <https://doi.org/10.1016/j.gloenvcha.2009.06.001>
- Palomo, I., M. R. Felipe-Lucia, E. M. Bennett, B. Martín-López, and U. Pascual. 2016. Disentangling the pathways and effects of ecosystem service co-production. *Advances in Ecological Research* 54:245-283. <https://doi.org/10.1016/bs.aecr.2015.09.003>
- Park, Y., and J.-M. Guldmann. 2020. Understanding disparities in community green accessibility under alternative green measures: a metropolitan-wide analysis of Columbus, Ohio, and Atlanta, Georgia. *Landscape and Urban Planning* 200:103806. <https://doi.org/10.1016/j.landurbplan.2020.103806>
- Parker, D., K. Soanes, and S. Roudavski. 2022. Interspecies cultures and future design. *Transpositiones* 1(1):183-236. <https://doi.org/10.14220/9783737013826.183>
- Pelling, M., K. O'Brien, and D. Matyas. 2015. Adaptation and transformation. *Climatic Change* 133(1):113-127. <https://doi.org/10.1007/s10584-014-1303-0>
- Pereira, L., N. Frantzeskaki, A. Hebinck, L. Charli-Joseph, S. Drimie, M. Dyer, H. Eakin, D. Galafassi, T. Karpouzoglou, F. Marshall, M.-L. Moore, P. Olsson, J. Mario Siqueiros-Garcia, P. van Zwanenberg, and J. M. Vervoort. 2020. Transformative spaces in the making: key lessons from nine cases in the Global South. *Sustainability Science* 15(1):161-178. <https://doi.org/10.1007/s11625-019-00749-x>
- Pereira, L. M., T. Hichert, M. Hamann, R. Preiser, and R. Biggs. 2018a. Using futures methods to create transformative spaces: visions of a good Anthropocene in southern Africa. *Ecology and Society* 23(1):19. <https://doi.org/10.5751/ES-09907-230119>
- Pereira, L. M., T. Karpouzoglou, N. Frantzeskaki, and P. Olsson. 2018b. Designing transformative spaces for sustainability in social-ecological systems. *Ecology and Society* 23(4):32. <https://doi.org/10.5751/ES-10607-230432>
- Pérez Rubi, M., and J. Hack. 2021. Co-design of experimental nature-based solutions for decentralized dry-weather runoff treatment retrofitted in a densely urbanized area in Central America. *Ambio* 50(8):1498-1513. <https://doi.org/10.1007/s13280-020-01457-y>
- Pineda-Pinto, M., N. Frantzeskaki, M. Chandrabose, P. Herreros-Cantis, T. McPhearson, C. A. Nygaard, and C. Raymond. 2022. Planning ecologically just cities: a framework to assess ecological injustice hotspots for targeted urban design and planning of nature-based solutions. *Urban Policy and Research* 40 (3):206-222. <https://doi.org/10.1080/08111146.2022.2093184>
- Pineda-Pinto, M., C. Kennedy, M. Collier, C. Cooper, M. O'Donnell, F. Nulty, and N. R. Castañeda. 2023. Finding justice in wild, novel ecosystems: a review through a multispecies lens. *Urban Forestry & Urban Greening* 83:127902. <https://doi.org/10.1016/j.ufug.2023.127902>
- Pineda-Pinto, M., M. Lennon, C. Kennedy, M. O'Donnell, E. Andersson, K. Wijsman, and M. J. Collier. 2025. Realizing multispecies justice through a capability approach to promote nature-based solutions. *npj Urban Sustainability* 5(1):31. <https://doi.org/10.1038/s42949-025-00205-z>
- Poikolainen Rosén, A., M. Normark, and M. Wiberg. 2022. Towards more-than-human-centred design: learning from gardening. *International Journal of Design* 16(3):21-36.
- Prodanovic, V., P. M. Bach, and M. Stojkovic. 2024. Urban nature-based solutions planning for biodiversity outcomes: human, ecological, and artificial intelligence perspectives. *Urban Ecosystems* 27(5):1795-1806. <https://doi.org/10.1007/s11252-024-01558-6>
- Raymond, C. M., N. Frantzeskaki, N. Kabisch, P. Berry, M. Breil, M. R. Nita, D. Geneletti, and C. Calfapietra. 2017. A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science & Policy* 77:15-24. <https://doi.org/10.1016/j.envsci.2017.07.008>
- Reed, M. S. 2008. Stakeholder participation for environmental management: a literature review. *Biological Conservation* 141 (10):2417-2431. <https://doi.org/10.1016/j.biocon.2008.07.014>
- Reed, M. S., A. C. Evely, G. Cundill, I. Fazey, J. Glass, A. Laing, J. Newig, B. Parrish, C. Prell, C. Raymond, and L. C. Stringer. 2010. What is social learning? *Ecology and Society* 15(4):r1. <https://doi.org/10.5751/ES-03564-1504r01>
- Reed, M. S., B. G. Merkle, E. J. Cook, C. Hafferty, A. P. Hejnowicz, R. Holliman, I. D. Marder, U. Pool, C. M. Raymond, K. E. Wallen, D. Whyte, M. Ballesteros, S. Bhanbhro, S. Borota, M. L. Brennan, E. Carmen, E. A. Conway, R. Everett, F. Armstrong-Gibbs, E. Jensen, G. Koren, J. Lockett, P. Obani, S.

- O'Connor, L. Prange, J. Mason, S. Robinson, P. Shukla, A. Tarrant, A. Marchetti, and M. Stroobant. 2024. Reimagining the language of engagement in a post-stakeholder world. *Sustainability Science* 19(4):1481-1490. <https://doi.org/10.1007/s11625-024-01496-4>
- Rigolon, A. 2016. A complex landscape of inequity in access to urban parks: a literature review. *Landscape and Urban Planning* 153:160-169. <https://doi.org/10.1016/j.landurbplan.2016.05.017>
- Rocks, S., D. Carson, and A. Gilmore. 2007. Understanding small business enterprise networking: a qualitative case approach. Pages 214-231 in D. Hine and D. Carson, editors. *Innovative methodologies in enterprise research*. Edward Elgar, Cheltenham, UK. <https://doi.org/10.4337/9781847204271.00021>
- Romani, A., F. Casnati, and A. Ianniello. 2022. Codesign with more-than-humans: toward a meta co-design tool for human-non-human collaborations. *European Journal of Futures Research* 10(1):17. <https://doi.org/10.1186/s40309-022-00205-7>
- Roudavski, S. 2020. Multispecies cohabitation and future design. In S. Boess, M. Cheung, and R. Cain, editors. *Synergy - DRS International Conference 2020*, 11-14 August. <https://doi.org/https://doi.org/10.21606/drs.2020.402>
- Roudavski, S. 2024. The ladder of more-than-human participation: a framework for inclusive design. *Cultural Science* 14(1):110-119. <https://doi.org/10.2478/cs-j-2024-0015>
- Rupprecht, C. D. D., J. Vervoort, C. Berthelsen, A. Mangnus, N. Osborne, K. Thompson, A. Y. F. Urushima, M. Kóvskaya, M. Spiegelberg, S. Cristiano, J. Springett, B. Marschütz, E. J. Flies, S. R. McGreevy, L. Droz, M. F. Breed, J. Gan, R. Shinkai, and A. Kawai. 2020. Multispecies sustainability. *Global Sustainability* 3:e34. <https://doi.org/10.1017/sus.2020.28>
- Sarabi, S., Q. Han, A. G. L. Romme, B. de Vries, R. Valkenburg, E. den Ouden, S. Zalokar, and L. Wendling. 2021. Barriers to the adoption of urban living labs for NBS implementation: a systemic perspective. *Sustainability* 13(23):13276. <https://doi.org/10.3390/su132313276>
- Schwarz, R. M., A. Davidson, P. Carlson, and S. McKinney. 2011. *The skilled facilitator fieldbook: tips, tools, and tested methods for consultants, facilitators, managers, trainers, and coaches*. John Wiley & Sons, San Francisco, California, USA.
- Spangenberg, J. H. 2011. Sustainability science: a review, an analysis and some empirical lessons. *Environmental Conservation* 38(3):275-287. <https://doi.org/10.1017/S0376892911000270>
- Stopher, P. R., and S. P. Greaves. 2007. Guidelines for samplers: measuring a change in behaviour from before and after surveys. *Transportation* 34:1-16. <https://doi.org/10.1007/s11116-006-0002-8>
- Taboada, M., J. Turner, J. Seevinck, and M. Foth. 2024. A worldbuilding approach for pluriversality in codesign. *CoDesign* 20(1):218-241. <https://doi.org/10.1080/15710882.2024.2349607>
- Tasker, T. J., and A. Cisneroz. 2019. Open-ended questions in qualitative research. Pages 119-122 in C. Haeussler Bohan, J. L. Pecore, F. S. Allaire, and S. O. Cannon, editors. *Curriculum & teaching dialogue*. Emerald, Leeds, UK.
- Tembo, D., G. Hickey, C. Montenegro, D. Chandler, E. Nelson, K. Porter, L. Dikomitis, M. Chambers, M. Chimbari, N. Mumba, P. Beresford, P. O. Ekiikina, R. Musesengwa, S. Staniszewska, T. Coldham, and U. Rennard. 2021. Effective engagement and involvement with community stakeholders in the co-production of global health research. *BMJ* 372:n178. <https://doi.org/10.1136/bmj.n178>
- Thompson Klein, J. 2004. Prospects for transdisciplinarity. *Futures* 36(4):515-526. <https://doi.org/10.1016/j.futures.2003.10.007>
- Threlfall, C. G., and D. Kendal. 2018. The distinct ecological and social roles that wild spaces play in urban ecosystems. *Urban Forestry & Urban Greening* 29:348-356. <https://doi.org/10.1016/j.ufug.2017.05.012>
- Trencher, G., M. Yarime, K. B. McCormick, C. N. H. Doll, and S. B. Kraines. 2014. Beyond the third mission: exploring the emerging university function of co-creation for sustainability. *Science and Public Policy* 41(2):151-179. <https://doi.org/10.1093/scipol/sct044>
- Tsing, A. L. 2015. *The mushroom at the end of the world: on the possibility of life in capitalist ruins*. Princeton University Press, Princeton, New Jersey, USA. <https://doi.org/10.1515/9781400873548>
- Van Patter, L., J. Turnbull, and J. Dodsworth. 2022. "More-than-human collaborations" for hacking the Anthropocene. *Feral Feminisms* 10:85-102.
- Voulvoulis, N., T. Giakoumis, C. Hunt, V. Kioupi, N. Petrou, I. Souliotis, C. Vaghela, and W. I. H. binti Wan Rosely. 2022. Systems thinking as a paradigm shift for sustainability transformation. *Global Environmental Change* 75:102544. <https://doi.org/10.1016/j.gloenvcha.2022.102544>
- Wagner, A., P. Polak, and M. Świątkiewicz-Mośny. 2019. Who defines-who decides? Theorising the epistemic communities, communities of practice and interest groups in the healthcare field: a discursive approach. *Social Theory & Health* 17(2):192-212. <https://doi.org/10.1057/s41285-018-0073-6>
- Waters, K. 2025. Return of the native: nostalgia and national renewal in narratives of rewilding. *ISLE: Interdisciplinary Studies in Literature and Environment* isaf090. <https://doi.org/10.1093/isle/isaf090>
- Webb, R., X. Bai, M. Stafford Smith, R. Costanza, D. Griggs, M. Moglia, M. Neuman, P. Newman, P. Newton, B. Norman, C. Ryan, H. Schandl, W. Steffen, N. Tapper, and G. Thomson. 2018. Sustainable urban systems: co-design and framing for transformation. *Ambio* 47(1):57-77. <https://doi.org/10.1007/s13280-017-0934-6>
- Westerlaken, M. 2020. *Imagining multispecies worlds*. Dissertation. Malmö University, Sweden.
- Westley, F., P. Olsson, C. Folke, T. Homer-Dixon, H. Vredenburg, D. Looorbach, J. Thompson, M. Nilsson, E. Lambin, J. Sendzimir, B. Banerjee, V. Galaz, and S. van der Leeuw. 2011. Tipping toward sustainability: emerging pathways of transformation. *Ambio* 40(7):762-780. <https://doi.org/10.1007/s13280-011-0186-9>
- Westley, F. R., O. Tjornbo, L. Schultz, P. Olsson, C. Folke, B. Crona, and Ö. Bodin. 2013. A theory of transformative agency in linked social-ecological systems. *Ecology and Society* 18(3):27. <https://doi.org/10.5751/ES-05072-180327>

Zamenopoulos, T., B. Lam, K. Alexiou, M. Kelemen, S. De Sousa, S. Moffat, and M. Phillips. 2021. Types, obstacles and sources of empowerment in co-design: the role of shared material objects and processes. *CoDesign* 17(2):139-158. <https://doi.org/10.1080/15710882.2019.1605383>

APPENDIX: LIMITATIONS AND MITIGATION STRATEGIES

While the co-design process in this research offers valuable insights, several limitations must be acknowledged. Firstly, the case study approach inherently restricts the generalizability of the findings (Simon and Goes 2013). Insights are deeply contextual, reflecting the unique socio-cultural, environmental, and institutional characteristics of the selected sites. The extensive history of environmental justice struggles, advocacy for waterfront access, and urban transitions in North Brooklyn has profoundly shaped community identity and engagement. This historical context likely influenced the workshop participants' readiness for co-design and the relatively narrow recruitment process. Consequently, the findings reflect the legacy of activism and the specific participant pool, fostering meaningful dialogue while further limiting generalizability. These outcomes are inherently context-dependent, as different participants, neighborhoods, or stages of urban change can yield varied results. Acknowledging this contextual specificity enhances the study's applicability and provides insight into adapting co-design approaches across diverse settings.

Furthermore, the co-design process's participatory nature introduces challenges to representation (Pain and Francis 2003). Despite efforts to include diverse participant groups, achieving comprehensive representation remains difficult. Marginalized voices may still be underrepresented, and power dynamics among participants could affect outcomes. Additionally, the time constraints of the workshops may limit the depth of collaboration (Del Gaudio et al. 2017), as well as limitations in longitudinal data. Co-design is a complex, iterative process that requires sustained engagement, so the workshops may not fully capture the long-term challenges or evolving priorities of interested parties. Another significant limitation of this research is the inherent selectivity regarding the species and ecosystems included, the manner of their inclusion, and the rationale behind it. While advocating for a multispecies co-design approach, practical and conceptual constraints hinder the achievement of fully representative inclusion. This research does not aim to comprehensively explore multispecies representation; instead, it focuses on how co-design processes can promote multispecies recognition. The study examines how these processes may lead to shifts in value and potential transformations within systems by emphasizing recognition.

Finally, researcher bias and facilitation style may unintentionally shape discussions and outputs, thereby influencing findings (Scott 2011). Reflexive practices have been employed to mitigate this issue, but complete neutrality remains unattainable. Several mitigation strategies have been implemented to address the process's limitations. Efforts to enhance representation included targeted outreach and partnerships with local organizations to ensure diverse actor participation, particularly from underrepresented groups. To address the time-bound nature of the workshops, follow-up interviews and supplementary surveys were conducted, enabling deeper exploration and iterative feedback. Reflexive practices, such as maintaining a research journal, involving co-facilitators, and inviting external reviewers, have helped minimize researcher bias and ensure transparency. These strategies collectively strengthened the research's inclusivity and reliability while acknowledging inherent contextual constraints.

LITERATURE CITED

- Del Gaudio, C., C. Franzato, and A. J. de Oliveira. 2017. The challenge of time in community-based participatory design. *URBAN DESIGN INTERNATIONAL* 22:113-126. <https://doi.org/https://doi.org/10.1057/s41289-016-0017-5>
- Pain, R. and P. Francis. 2003. Reflections on participatory research. *AREA* 35(1):46-54. <https://doi.org/https://doi.org/10.1111/1475-4762.00109>
- Scott, A. 2011. Focussing in on focus groups: Effective participative tools or cheap fixes for land use policy? *Land Use Policy* 28(4):684-694. <https://doi.org/https://doi.org/10.1016/j.landusepol.2010.12.004>
- Simon, M. K. and J. Goes. 2013. Scope, limitations, and delimitations.

Appendix 2. Data extraction file from the workshops, surveys and interviews

[Please click here to download file 'appendix2.xlsx'.](#)
