

More than a mirror: embedding reflexivity for transformative sustainability research

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Abstract: Reflexivity is regarded as essential for enabling transformative transdisciplinary research, yet it remains a marginal practice that is weakly institutionalised. This Perspective draws on the experiences of the Reflexivity Task Force, a dedicated group of researchers established to embed reflexivity within the Horizon Europe BIONEXT project. We show that intentionally designed reflexive interventions can surface hidden biases, power dynamics and divergent perspectives influencing transdisciplinary research. However, barriers to engaging researchers with more conflictual or deeply entrenched dimensions of positionality and power can lead to ‘safe’ forms of reflection with limited impact on research outcomes. We argue that making reflexivity more than a mirror requires institutional transformation, moving reflexivity from an optional practice to a core scientific capacity embedded within research governance, funding and evaluation systems. Importantly, this institutionalisation of reflexivity must not come at the cost of maintaining its provocative spirit, which requires deliberative engagement with pluralism and contestation.

Keywords: knowledge co-production, transdisciplinary, critical, epistemology, learning

1. The call for reflexivity in sustainability research

Transformative change is required to secure a liveable planet for people and nature (IPBES, 2024). In response, research is increasingly expected to contribute not only to understanding sustainability challenges, but to shaping solutions. Transdisciplinary research is an approach for co-producing integrative, action-oriented knowledge for sustainability by weaving together academic disciplines with the knowledge of societal actors beyond academia (Caniglia et al., 2020; Lang et al., 2012). A crucial contribution of transdisciplinary research is ensuring that solutions are actionable and grounded in dynamic complexity through a practice-based, societally embedded approach (West et al., 2019).

Transdisciplinary research can be transformative by generating novel solutions that contest dominant views, structures and practices underpinning complex sustainability challenges (Augenstein et al., 2024; Fazey et al., 2020). However, this transformative potential is often impeded by unacknowledged but persistent biases and power dynamics that shape whose knowledge is recognized, how problems are framed, and which solutions are considered legitimate (Fritz et al., 2026; Lazurko et al., 2024; Wiegler & Bruns, 2023). Misunderstanding and conflictual interpretations can emerge in collaborations across disciplines or between actors with divergent worldviews (Hertz & Schlüter, 2015; Strang, 2009; Turnhout, 2019). When the underlying power dynamics between these different perspectives are not addressed, a drive for consensus can mask divergent views (Gregory, 1996; Ulrich, 2003) or stifle transformative insights that originate from marginalised knowledge systems or are yet unknown (Bornemann & Christen, 2020; Turnhout et al., 2026).

These dynamics become particularly important in science-policy settings, where research actively shapes solutions, policy options and notions of feasibility (Borie et al., 2021; Turnhout, 2024). In such contexts, unexamined power relations within transdisciplinary research risk reproducing dominant policy logics, even when participatory or integrative approaches are adopted (Turnhout et al., 2020, 2026; Wyborn et al., 2021). As researchers hold the authority to determine methodological choices and whose knowledge counts in transdisciplinary processes (Reed et al., 2023), they must also bear responsibility for the process and the outcomes of their decisions.

Reflexivity has been called upon as a crucial capacity to address this responsibility (Lazurko et al., 2024; Popa et al., 2015; von Seggern et al., 2023). Reflexivity is often colloquially understood as a mirror, enabling the critical examination of one's own biases and their influence on a situation. Positioned as a transformative capacity in sustainability research, reflexivity becomes more than a mirror: a "dynamic, embedded and collective process of self-scrutiny and mutual learning in service of transformative change" (Lazurko et al., 2025). The transformative potential of reflexivity lies in its role in surfacing and mediating the hidden biases and power dynamics that shape how diverse worldviews, disciplines and perspectives are integrated to inform solutions. Reflexivity thus enables more inclusive and adaptive research processes: for example, by creating space to elevate perspectives that appear marginalised (McIntyre et al., 2023; Staffa et al., 2022) or creating conditions that allow plurality to surface and be deliberated in ways that meaningfully influence the research outcomes (Cockburn, 2022; Turnhout, 2024).

The importance of reflexivity is further acknowledged through its recognition as one of the four pillars of societal readiness, which is increasingly regarded as being as important as technological readiness in research and development projects (Francis et al., 2026). Together with inclusion, anticipation, and responsiveness, reflexivity is expected to ensure that research outcomes align with long-term societal values, needs, and expectations (Bernstein et al., 2022). As funding agencies

increasingly require researchers to address societal readiness, there is a growing need for practical, ready-to-use tools that can be readily implemented in research projects (Braun et al., 2025).

Researchers are responding to these calls for reflexivity. For example, transdisciplinary frameworks weave together multiple knowledge systems (Chilisa, 2017; Martin, 2012; Tengö et al., 2014), support iterative and collective evaluation of the research process with participants beyond academia (Hubeau et al., 2018; Mitchell et al., 2015), and help researchers reflexively choose different roles, epistemological commitments and methodological approaches (Chambers et al., 2022; Haider et al., 2018). Positionality statements are becoming more common in research outputs. Emerging critical literature highlights the limitations of the self in the mirror (Haider & Rieser, 2025) and argues that reflexivity must be provocative in order to avoid reproducing the status quo (Hakkarainen & Lazurko, 2025). Nevertheless, researchers often struggle to embed critical approaches into transdisciplinary research – including and beyond reflexivity – within academic and science-policy institutions that were not designed with reflexive practice in mind (Cockburn & Cundill, 2018; Sellberg et al., 2021). These responses create barriers that limit the transformative potential of transdisciplinarity

This Perspective draws key lessons learned from a transdisciplinary experiment that aimed to address these challenges: the Reflexivity Task Force, a dedicated group of researchers from diverse institutions, disciplines and countries, established to embed reflexivity within the Horizon Europe BIONEXT project. In this paper, we argue that significant institutional shifts are required to make reflexivity more than a mirror, surfacing blindspots that capture its transformative potential for transdisciplinary sustainability research. To inform this argument, we draw from our experiences establishing the task force and implementing a series of reflexive interventions (Section 2). We share the insights and learning that emerged from these interventions (Section 3), informing our assessment regarding whether and how these interventions became transformative (Section 4). These reflections inform our call to action (Section 5), prompting research governance, funding and evaluation systems to move reflexivity from an optional practice to a core scientific capacity while maintaining its provocative spirit.

2. Methods: formation, interventions and reflections of the Reflexivity Task Force

All co-authors of this paper are connected to the BIONEXT project. The consortium is represented by six core members of the Reflexivity Task Force and five researchers who participated in the task force's activities, while the remaining four authors are non-consortium participants from different sectors of society who were involved throughout the project co-creation process. Together, the co-authors provide a balanced view of the task force's activities and impact. BIONEXT is a research project involving ten partners across nine European countries that aimed to drive transformative change and centre biodiversity in society, policymaking, and key sectors such as food, water, energy, transport, climate, and health. Researchers in the project are highly interdisciplinary, spanning diverse natural and social sciences, with many identifying themselves as inter- or transdisciplinary. Non-consortium participants are part of a fluctuating group of 20 to 25 key actors who were invited into the project co-creation workshops to represent expertise across policy sectors (i.e., biodiversity, energy, food, health, water, transport), organisations (research, government, civil society/non-governmental organisation, business and minority groups) and geographic regions (i.e., western, southern and central/eastern Europe).

2.1 Formation of the task force

The Reflexivity Task Force emerged informally during the first co-creation workshop and consortium meeting of the BIONEXT project in May of 2023, in Santorini, Greece. As a Horizon Europe-funded project aiming to generate knowledge relevant for biodiversity governance across policy sectors, BIONEXT itself operates as part of the science-policy interface. Against this backdrop, a small group of BIONEXT researchers found common ground in our critical, exploratory questions about positionality and knowledge integration in transdisciplinary research. They became the founding members of the Reflexivity Task Force, with additional members joining shortly thereafter to ensure diversity across the project partners and work packages. Throughout the project, the task force fluctuated between 4 and 7 members, anchored by this founding group.

From its inception, the Reflexivity Task Force was motivated by a strong belief that reflexivity is essential for rigorous and inclusive transdisciplinary research. Members drew on prior academic work and professional experience in reflexivity, action research, epistemic justice and positionality. They also joined based on experiential insights from practice beyond academia, bringing perspectives shaped by roles such as parenting, volunteering with refugees, working in mental health care, government, and collaborating with local communities, citizens and NGOs. Together, these motivations fostered a collective ambition to make reflexivity accessible, challenge unexamined assumptions, and support both personal and institutional learning.

Early stages of the task force allowed for collective sense-making around the project, our roles, and our ways of collaborating within the consortium, which in itself became a key learning outcome of this work. Limited anchoring in the original project structure enabled experimentation, but also affected the task force's perceived legitimacy within the wider consortium, especially in the early days. Despite these challenges, the Reflexivity Task Force developed a clear identity and path forward. Its explicit aim became to facilitate an interactive and constructive process of reflexivity around researchers' and participants' perspectives and subjectivities in the BIONEXT consortium, and how these influenced joint research outcomes. This aim was operationalised through a series of reflexive interventions embedded in the project, as described in the following sections.

2.2 Interventions of the task force

Reflexivity was embedded in BIONEXT through a series of concrete interventions. These interventions targeted three dimensions: 1) reflexivity among researchers, 2) reflexivity between researchers and co-creation participants, and 3) reflexive evaluation of the research process itself. While some interventions were planned initially, most emerged iteratively in response to the project dynamics, ambitions and constraints. In this section, we introduce the interventions and the key insights gained. Table 1 provides an overview of the interventions. The findings from each of these interventions were summarised for key learnings and outcomes. These summaries were then further synthesised into three themes that cut across the interventions, as presented in Section 3.

162 Table 1: Summary of reflexive interventions embedded into the BIONEXT transdisciplinary research project and the data used for the analysis in this paper

Dimension	Reflexive intervention	Data used for analysis	Dates	Purpose related to reflexivity
Researcher reflexivity	Researcher interviews	11 transcribed interviews	March-April 2024	- Explore individual researcher perspectives and positionality and their role in research design (e.g., discipline, values, motivation, career stage) - Expose diverse perspectives on key topics in transdisciplinary research (e.g., complexity, quality of knowledge)
	Virtual researcher workshop	Notes from two discussions	February 2025	- Facilitate collective reflection on key tensions and divergent perspectives in findings of researcher interviews (see activity a) - Test initial ideas to translate insights into a reflexive tool
	Development and testing of a reflexive tool	Feedback and notes from discussions	January 2025 – January 2026	- Translate insights from the Reflexivity Task Force into a practical tool that can foster more critical, transparent dialogue within research teams - Develop and test the tool within the BIONEXT project, facilitating collective learning about epistemic differences, divergent perspectives and power dynamics in transdisciplinary research
Participant-researcher reflexivity	Reflexivity moments in the co-creation workshop series	Notes and surveys from workshops with 23 to 30 participants	May 2024, May 2025, May 2026	- Explore and discuss unique participant perspectives and positionality and their influence on participant contributions (e.g., expertise domain, region, ethnicity, career stage) - Expose diverse hidden assumptions about personal roles, logics and priorities in transformative change to enable more collaborative discussions
	Participant interviews	9 transcribed interviews	June-July 2024	- Explore perceptions of knowledge integration related to co-creation workshop inputs, methods and group interactions - Expose diverse hidden assumptions about personal roles, logics and priorities in transformative change and their influence on participant contributions
Reflexive evaluation	Researcher surveys	15 filled in surveys	November 2025	- Evaluate the BIONEXT project for quality of knowledge integration according to key themes and priorities emerging from the Reflexivity Task Force - Evaluate the transformative potential of the Reflexivity Task Force - Understand the nature and extent of researcher learning through the activities of the Reflexivity Task Force
	Participant survey	9 filled in surveys	March-April 2026	- Evaluate the BIONEXT project for quality of knowledge integration according to key themes and priorities emerging from the Reflexivity Task Force - Evaluate the transformative potential of the Reflexivity Task Force

Researcher reflexivity

Researcher interviews

We conducted semi-structured interviews with eleven BIONEXT researchers to support early reflection on researchers' positionality and their perceived influence on methodological choices in the project. The interviews established a baseline for understanding how researchers conceptualised transdisciplinary research, complexity, and knowledge integration, and informed the project's joint conception of the quality of knowledge integration. Interviewees were selected to reflect diversity across project work packages, institutions, disciplines and career stages. The interviews were 60 to 90 minutes and followed an interview protocol (Appendix S1). Once transcribed, they were thematically analysed by pairs of Task force members.

Virtual researcher workshop

All BIONEXT researchers were invited to attend one of two 90-minute interactive virtual workshops held in February 2025. The workshops aimed to stimulate critical reflection and mutual learning by collectively discussing key findings and tensions emerging from the earlier researcher interviews. The sessions were structured around themes that emerged from the interviews, such as complexity, transdisciplinarity, influences on research choices, and knowledge integration, using interview-based prompts to provoke broader discussion. An early version of a reflexive tool was briefly tested at the end of the workshop (see below). Key points from the discussion were captured by note-takers, and were synthesised and analysed.

Development and testing of a reflexive tool

Building on the insights from the researcher interviews and virtual workshops, the task force developed, designed and iteratively tested a reflexive tool – the *Knowledge Integration Reflexivity Cards* (KIRC). The tool was structured to facilitate structured yet open dialogue about often implicit challenges of knowledge integration in transdisciplinary research, with the aim of fostering critical reflection, surfacing epistemic differences, and preventing the reinforcement of existing power dynamics. The tool evolved iteratively through analysis of earlier reflexive interventions and through testing across the project timeline.

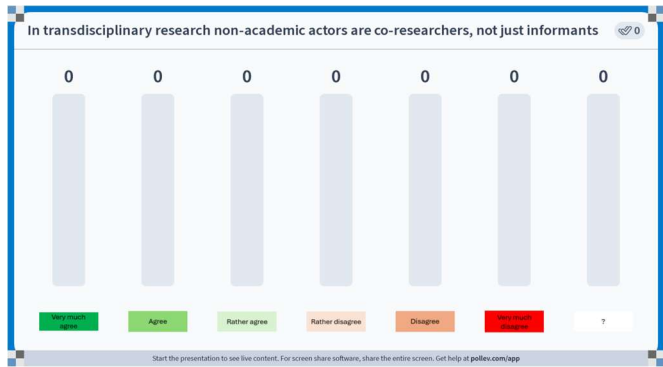


Fig.1: Example of a KIRC used to stimulate discussion among researchers about the quality of knowledge integration in transdisciplinary research

Initial versions of the KIRCs translated recurring challenges in transdisciplinary research into structured prompts linked to key collaboration processes. The cards were designed to encourage individual reflection followed by collective discussion on how knowledge integration took place in practice and where tensions or gaps emerged. Early testing of these cards generated feedback that prompted a revision of the tool, moving away from a detailed scoring format toward a smaller set of broader, tension-oriented statements that probed underlying assumptions in transdisciplinary

research practice. This later iteration of the KIRCs was tested with the wider BIONEXT consortium (see example in Fig. 1).

Participant-researcher reflexivity

Reflexivity moments in the co-creation workshop series

Four co-creative workshops with external participants were organised over four years to develop transformative pathways towards nature-positive futures for Europe and to inform actionable policy recommendations. Workshops were designed sequentially, with efforts to maintain a relatively stable group of approximately 25 participants to ensure continuity and shared understanding across sessions. Participants represented diverse geographic regions, sectors, occupations, genders and career stages. The workshops differed in terms of focus and methods used, but they all emphasised co-creation between the participants and sought to establish a safe-enough space for trust-building and dialogue. This was supported through informal activities, such as shared dinners, outdoor excursions, and hosting workshops in locations connected to nature and biodiversity.

Each workshop had a distinct focus within the overall research process and therefore provided different opportunities for embedding reflexivity. The first workshop centred on co-creating European-level nature-positive shared visions, foregrounding values (Lazurko, de Pater, et al., 2025; Lazurko, Kim, et al., 2025). The second workshop focused on the co-creation of just transformative pathways, which represent tangible actions that connect the present to the envisioned futures from the first workshop (De Pater et al. 2025). The third workshop focused on reinforcing the earlier co-created just transformation pathways, building on a quantitative and qualitative analysis of the pathways, which highlighted weaknesses, strengths, and potential opportunities. The fourth workshop focused on translating these findings into transformative action for biodiversity.

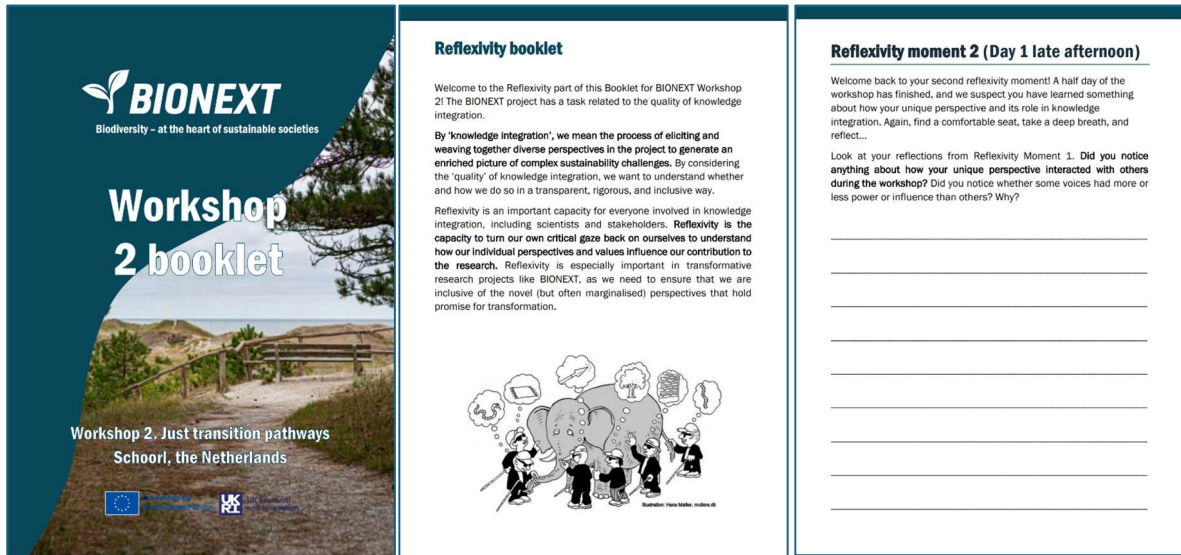


Fig. 2: Example pages from the reflexivity booklet, used to stimulate critical reflection and discussion among participants and researchers during the second co-creation workshop of the BIONEXT project.

The Reflexivity Task Force complemented the core workshop design by embedding targeted “reflexivity moments” aligned with the specific aims of each workshop. In the first workshop, reflexivity was not an explicit aim, but informal conversations during the workshop and subsequent consortium meeting resulted in the formation of the task force. In the second workshop, reflexivity moments were made explicit, through structured moments of 10-20 minutes in the workshop agenda. Using an individual journal, the reflexivity booklet (Fig. 2), participants and researchers were

guided through individual and collective reflexive exercises to stimulate discussion. Based on participant feedback from the second workshop, reflexivity moments shifted towards fewer but longer sessions for the third workshop. This included an initial intention-setting exercise – revisiting individual perspectives and articulating intentions for engaging with difference – and extended facilitated dialogues that explicitly addressed underlying assumptions about transformative change in knowledge generation. These dialogues made use of embodied and spatial formats, such as positioning exercises, to encourage participants to engage with disagreement, plurality, and contestation as aspects of collective sense-making (Fig. 3). In the fourth and final workshop, participants were invited to reflect on the co-creation journey and discuss their role and learnings across the whole experience. Across workshops, reflexivity moments were adapted to evolving project needs, participant feedback, and the changing nature of the co-creation process.



Fig. 3: Facilitators and participants outside in Teplice, Czechia for the reflexivity dialogues

Participant interviews

Interviews were conducted with nine participants shortly after the second BIONEXT workshop in June and July 2024. The aim of the interviews was to reflect on the processes of knowledge integration and learning that occurred during the workshop, considering the diversity of inputs, methods, and interactions between participants and facilitators. The interviews also explored participants' individual and collective assumptions about transformative change, as well as how workshop dynamics shaped these perspectives and the resulting outputs. The interviews built on the personal reflexivity booklet (Fig. 2), and participants were encouraged to consult their booklets during the interviews to support reflection directly on workshop experiences. The interviews were recorded, anonymised and analysed using thematic content analysis by at least two researchers. The full interview protocol can be found in Appendix S2.

Reflexive evaluation

Researcher survey

A survey was administered to the full BIONEXT consortium, including members of the task force, within the final year of the project. The aim of the survey was twofold. First, the survey aimed to

evaluate the quality of knowledge integration in BIONEXT through the key themes that emerged from prior reflexive interventions including researcher interviews, the virtual researcher workshop and the development and testing of the reflexive tool. Second, it aimed to evaluate the overall impact of the Reflexivity Task Force activities on researchers. The survey was administered through Microsoft Forms, and answers from the fifteen respondents were analysed using thematic analysis. The full survey protocol can be found in Appendix S3.

Participant survey

A survey was administered to the participants in the co-creation workshop series for BIONEXT within the final year of the project, targeted at those who participated in the interviews. The aim of the survey was to gather feedback on the impact of the Reflexivity Task Force activities. The survey was administered through Microsoft Forms, and answers from the seven respondents were analysed using thematic analysis. The full survey protocol can be found in Appendix S4.

2.3 Assessing the transformative potential of the task force

We assessed the extent to which the reflexive interventions were transformative. To do so, a survey was circulated among all listed co-authors (Appendix S5) and participants who were involved in both the co-creation workshops and interviews (Appendix S4). The anonymised survey results were analysed to generate the collective assessment presented in Section 4, which was validated by all co-authors to ensure a balanced presentation of diverse views.

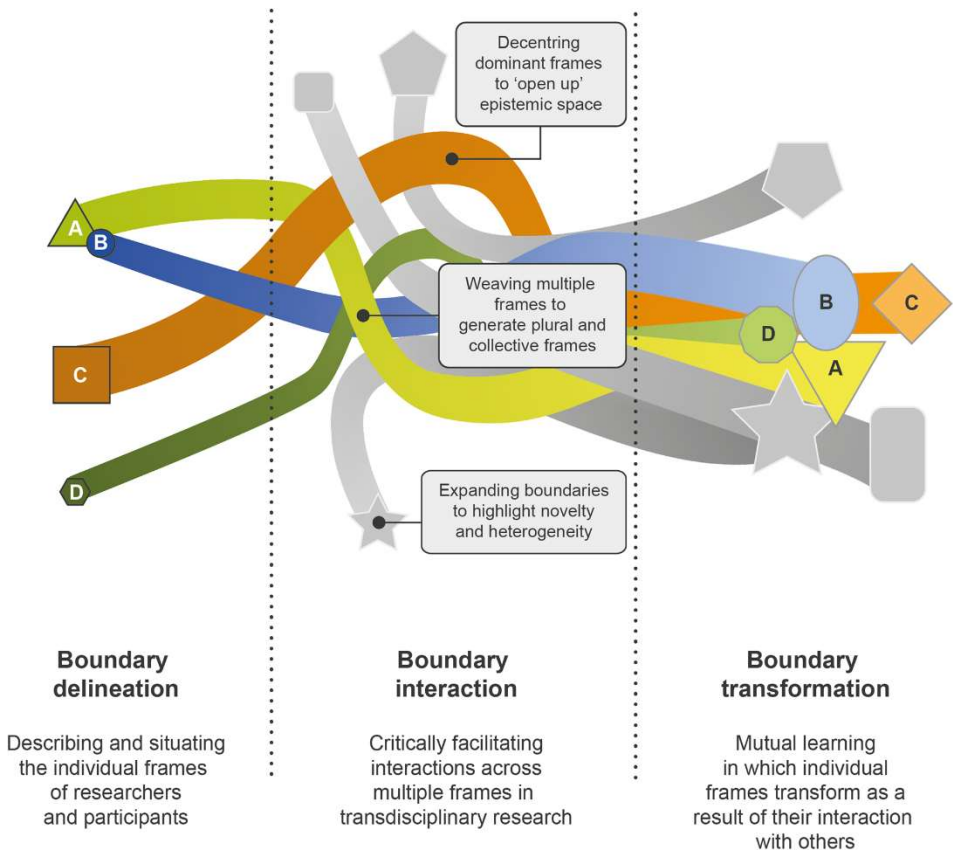


Fig.4: Boundary processes involved in reflexivity as a transformative capacity (Lazurko et al. 2025)

The survey and resulting reflection were structured by a framework introduced in Lazurko et al. (2025), depicted in Fig. 4. This framework conceptualises reflexivity as unfolding through three

interacting boundary processes: i) *Boundary delineation* refers to recognising and critically examining the positionality, assumptions, and power relations shaping individuals' perspectives; ii) *Boundary interaction* involves engaging multiple perspectives to enable inclusive and plural forms of knowledge integration, including decentring dominant boundaries and sustaining plurality and difference, which requires allowing for messy and political processes of disagreement, rather than forcing consensus; and iii) *Boundary transformation* describes processes of mutual learning, where individual frames transform toward a greater appreciation for difference, due to encounters with others.

Together, these processes describe how individual and collective perspectives are surfaced, brought into dialogue, and potentially reshaped through engagement with others over time. This framing is particularly useful for analysing how reflexivity operates in practice, beyond individual self-reflection, by putting the relational and dynamic nature of knowledge integration at the centre.

2.4 Generating a collective reflection

This paper reflects the joint perspective that emerged from the experiences and findings of the Reflexivity Task Force. When synthesising the findings of the reflexive interventions to form a collective perspective (Section 3), assess whether they were transformative (Section 4) and what should be done to further reflexivity (Section 5), we stayed as true to the data and balanced as possible as we sought cross-cutting themes that speak to wider issues in the sustainability research field. This required some degree of interpretation that highlights the voice and positionality of the co-author team.

3. What the reflexive interventions revealed

This section describes the findings of the reflexive interventions implemented by the Reflexivity Task Force in BIONEXT (Section 2.2), revealing cross-cutting insights for both researchers and participants.

3.1 Divergent perspectives exist on key aspects of transdisciplinary research

Researcher insights

The researcher interviews and virtual workshop together exposed multiple perspectives on key assumptions informing their approach to transdisciplinary research. These included divergent views on what transdisciplinary research is, how it should be operationalised, and whether these expectations were met in BIONEXT. The co-creation of visions and pathways toward nature-positive futures in BIONEXT was referenced as evidence of transdisciplinarity, for those who view it as a collaboration between scientists and non-academic actors to generate societally relevant knowledge. Others highlighted the nature of our research questions and methods, which required strong collaboration between disciplines.

Diverse interpretations of the role of complexity in our research also emerged, with some researchers focused on complexity in the research content, such as framing sustainability challenges as interconnected systems characterised by uncertainty, emergence, and societal complexity. In contrast, others focused on the research process, including challenges of coordinating collaboration, integrating knowledge, and generating evidence about patterns in such complex systems.

The development and testing of the reflexive tool built upon these findings to stimulate more detailed, collective discussions about divergent assumptions informing transdisciplinary research. For example, prompts from the KIRC tool stimulated critical, collective reflection on what constitutes “actionable” knowledge, how scientific robustness and rigour are understood in transformative

research contexts, whether participants beyond academia are treated as equitable knowledge holders, and how researchers perceive their role in transformative change.

Participant insights

The participant interview analysis also surfaced distinct perspectives related to the quality of knowledge integration in the workshop and the BIONEXT project more broadly. Some participants emphasised the importance of conventional modes for ensuring scientific legitimacy, such as validation of participant assumptions with scientific evidence and the importance of relying on peer review from scientific authorities. This insight was complemented by others emphasising the diversity of perspectives in knowledge integration, including marginalised groups and those with different political ideologies. Some participants emphasised the crucial role of outlier or radical perspectives to push co-creation processes toward more transformative outcomes.

Reflexivity moments across the co-creation workshops surfaced additional tensions affecting the transdisciplinary research process. In particular, reflexivity moments in Workshop 2 revealed differing views on the purpose of the transformative pathways exercise, including tensions between radical ambition and feasibility in the transformative pathways, between striving for consensus and maintaining plurality, and between facilitation aimed at eliciting discussions versus driving toward concrete outputs. The reflexive dialogues conducted during Workshop 3 generated understanding among researchers and participants about the importance of mediating these tensions productively.

3.2 Researcher positionality plays a role in methodological choices

Researcher insights

Importantly, the researcher interviews revealed how methodological choices in BIONEXT are shaped by personal subjectivities, making visible the links between positionality and research outcomes. Most interviewees saw themselves as situated and subjective observers of transformative change, while only a minority saw themselves as fully neutral and independent. Researchers pointed to factors such as career stage, disciplinary background, expertise, personal motivations and values as influential in defining key research activities. The interviews also surfaced important considerations for ensuring the quality of knowledge integration in transdisciplinary research, including transparency in research design, and reflexivity and honesty in communicating the findings and limitations of the research.

The virtual researcher workshop furthered discussions on the role of subjectivity and objectivity in influencing research choices. Researchers resisted the idea that transdisciplinary research could or should produce objective knowledge, instead highlighting their role in generating useful knowledge under conditions of uncertainty, which requires being transparent about the research process and the limitations of findings. Researchers also reflected on pressures to uphold conventional norms of scientific rigour associated with neutrality and objectivity, despite knowing that research outcomes are shaped by situated assumptions and choices. They also reflected that scientists may have an overstated fear of communicating uncertainty to decision-makers, which limits our impact.

3.3 Power dynamics shape the process of knowledge integration

Researcher insights

The virtual researcher workshop built upon the researcher interview findings to surface deeper power dynamics influencing knowledge integration. Researchers debated whether BIONEXT sufficiently facilitates equitable collaboration between researchers and non-academic actors, noting

that researchers' control over proposal design and methodological decisions, which is often necessary to secure funding and meet deliverables, can limit participants' influence. This is also influenced by senior researchers who had pre-existing collaborations that influenced the proposal process. While European-level policy involvement in shaping the funding calls was seen as one way to address this lack of influence, mismatches between policy agendas and research timelines were identified as a key challenge. Participants also questioned whether the European scale hindered deeper engagement with actors embedded in specific local contexts, particularly where some 'participants' were themselves scientists representing policy or practice perspectives.

During the workshop, process-level tensions emerged between control and flexibility in managing a highly complex research project, which may privilege certain approaches and perspectives in research. While individual researchers expressed frustration with this tension during interviews, in the workshop they discussed how this tension may be productive and inherent to transdisciplinary research: while structures such as deliverables and timelines enable coordination and progress, flexibility is essential for responding to emergent insights and enabling novel collaboration beyond 'promised deliverables' across a diverse project consortium. Differences in comfort with predesigned versus open-ended work highlighted a push-pull between different styles of doing science and their impacts on researchers, particularly those earlier in their careers.

Overall, the research survey reinforced that through the task force activities, we were able to surface previously hidden or unacknowledged dynamics influencing the quality of knowledge integration.

Participant insights

Retrospective feedback sessions and surveys during the co-creation workshop series reveal that participants also experienced power dynamics among each other and researchers in the transdisciplinary research process. They reflected on how facilitation choices and workshop design influenced whose perspectives were foregrounded and how disagreements were handled. Some reflections pointed toward strong personalities or professional authority, noting that considerable effort was sometimes required to ensure diverse perspectives were heard. These dynamics became particularly visible when participants looked back on moments where underlying assumptions had shaped discussions and contributions.

Participant interviews surfaced key considerations for balancing power differences in knowledge integration, which requires careful management of personalities, ideologies and time by the facilitation team to ensure that rich discussions and debate eventually coalesce in a coherent way that does not under- or overemphasise particular perspectives. Participants also emphasised that humble facilitation, creative methods and attention to group size and heterogeneity are crucial for influencing knowledge integration. They also reflected on their own personal responsibility to be aware of how personal values, knowledge or assumptions influence their contributions, offering helpful suggestions to shape future efforts to embed reflexivity in transdisciplinary research practice.

During workshop feedback sessions, many participants felt that despite these power dynamics, their perspectives were reflected in the workshop outputs, although several noted that this often required sustained effort to navigate disagreement.

3.4 Impactful and rigorous transdisciplinary research is possible, but challenging

Researcher insights

The researcher survey results suggest that the BIONEXT project was largely perceived as supporting high-quality and impactful transdisciplinary research, with limitations. Most respondents highlighted strong collaboration and that the project produced impactful insights capable of influencing transformative change. The majority also agreed that the project effectively achieved true, integrated collaboration across all project partners, researchers and participants beyond academia – with many noting this was unique relative to other projects. Most respondents also agreed that the project used a scientifically robust approach to integrating different forms of knowledge.

At the same time, some respondents identified limitations, including uneven collaboration with participants across work packages, limited partner involvement in the project conception phase, hierarchical or authority-based dynamics, and differing opinions. Views were also mixed regarding the replicability of the approach and its ability to motivate action.

3.5 Reflexive interventions stimulated learning, with limited direct impact on research outcomes

Researcher insights

Responses to the researcher survey revealed positive responses to the activities of the Reflexivity Task Force, with most respondents recognising the importance of reflexivity for knowledge integration and a clear understanding of the task force's aims – even though a majority of the respondents were new to the topic at the beginning of the project. Many highlighted they would take learning from the Reflexivity Task Force into their future work, citing the task force's strengths as encouraging reflection on their own scientific practice in an open, accessible way, increasing recognition of one's responsibility for accountability and transparency, awareness of potential biases, and supportive of collaboration and team learning across the consortium. The Reflexivity Task Force was also appreciated for the exposure to new methods, such as the Reflexivity Booklet.

However, when assessing the tangible impact of the Reflexivity Task Force, responses were mixed. While some reported shifts in perspective and improved understanding of other's viewpoints (e.g. "[it] gave me an a-ha feeling, finally understanding the ways of thinking of some participants and partners"), others found it difficult to attribute learning directly to the task force activities. Researchers pointed to challenges such as a lack of clarity and accessibility in the initial phase, alongside challenging terminology and concepts, as well as varying levels of engagement and interest across the consortium. Some had the impression that many researchers did not care about, understand, or take reflexivity seriously, limiting the impact of activities. In short, while the reflexive interventions were broadly appreciated, their impact was dependent on how clearly they were communicated, how accessible they were, and the extent to which researchers engaged with them.

Participant insights

Participant responses to the survey were similar, revealing that the task force was generally well received by those involved in co-creation workshops and participant interviews. Most respondents reported a clear understanding of its overarching aims, and agreed that embedding reflexive processes in transdisciplinary research is important for enhancing the quality of knowledge integration. Participants identified several key strengths, including the provision of a safe and

structured space for reflection and dialogue, which facilitated the surfacing of diverse perspectives, the examination of individual assumptions, and the consolidation of knowledge. Additional strengths included the stimulation of critical thinking, encouragement of more qualitative contributions, promotion of mutual respect, and reinforcement of the integrity and coherence of the overall process.

At the same time, participants identified weaknesses. Some perceived the reflexive interventions as an “add-on,” with unclear connections to the project’s decision-making processes and overall outputs. One participant suggested that assumptions regarding participants’ viewpoints may have contributed to a degree of reluctance to engage, whereas others argued that reflexive practices can instead help to foreground a wider range of perspectives. Time constraints associated with task force activities were also identified as a major challenge. Nevertheless, one participant noted that, although initially perceived as burdensome, the activities ultimately encouraged them “to pause, refrain from action, and reflect,” thereby highlighting the importance of allocating adequate time for reflexive engagement.

4. Whether the reflexive interventions were transformative

This section presents reflections from the assessment of the transformative potential of the activities of the Reflexivity Task Force (Section 2.3), according to the framework in Figure 1.

4.1 Boundary delineation: Making power and positionality visible

The activities of the Reflexivity Task Force stewarded *boundary delineation* to a certain extent, revealing that critical reflection occurred but avoided more power-laden aspects of positionality.

For researchers, the interviews clarified factors that shape individual researcher perspectives, and the virtual workshop enriched researchers’ boundary delineation by enabling them to see their perspectives synthesised and contrasted with those of others. In some cases, this allowed for critical reflection on power dynamics – such as between disciplines or between senior and junior researchers. This process may have encouraged new approaches, such as senior scientists creating more space for junior scientists to innovate, and efforts to foster more reciprocal relationships with participants in co-creation processes. The use of mixed methodologies was also seen as a way to even out disciplinary power dynamics by allowing multiple forms of expertise to contribute to a shared research objective.

However, because the interview protocol and virtual workshop allowed researchers to define which factors they considered relevant, more power-laden factors – such as age, race and class or distinct ontological or epistemological commitments – rarely surfaced. As demographic data was not systematically collected, these dimensions could not be integrated into our analysis. As a result, processes of boundary delineation remained depoliticised and relatively ‘safe’, limiting their transformative potential as researchers were not explicitly encouraged to explore their blind spots. Additionally, as an isolated activity, the researcher interviews had limited impact for most participants. Reflexive learning only became tangible when interviewees saw their perspectives synthesised with others during the virtual researcher workshop. Thus, most learning occurred within the task force, as members of the task force nuanced their own boundary delineation through exposure to the diverse perspectives across the eleven interviewees.

For participants, the reflexivity moments and interviews also clarified key factors shaping and potentially constraining personal perspectives and facilitated critical reflection on ontological and epistemological assumptions. Reflection on disciplinary hierarchies, career stage and factors related to class, age and ethnicity were mixed, indicating that, similar to the researcher-focused activities, these interventions may have failed to move beyond reflexivity as a mirror, toward more provocative, power-laden areas. Beneficial experiences for participants seemed dependent on their personalities and the dynamics of their group in workshops. For example, the involvement of two Sami individuals in one group led to important conversations about preconceived notions of their perspectives and how other participants ought to engage.

Key to participants' boundary delineation was surfacing which perspectives were excluded from the co-creation workshop series, helping both participants and researchers reflect upon the intrinsic power dynamics in participant selection and the resulting limitations for research outcomes. The participant interviews further clarified distinct political views or assumptions about transformative change that researchers were previously unaware of. This relates to a broader learning: that researchers' frames were transformed through their interaction with workshop participants, as "participants realised several of the criteria and transmitted them to the researchers, allowing a mutual transformation." However, despite these reflections, bigger questions about the structural power dynamics influencing how plural worldviews were discussed and incorporated, such as whether the co-creation process challenged or reinforced a European-centric framing of the biodiversity crisis, were left unaddressed.

4.2 Boundary interaction: Creating encounters across difference

The reflexive interventions stewarded *boundary interaction* in multiple ways. For researchers, these interactions were bounded in ways that limited direct impact on research outcomes, whereas boundary interaction through co-creation with participants enabled more impactful learning.

For researchers, the virtual workshop and reflexive tool partially supported boundary interaction among the research team. Discussions pushed thinking beyond disciplinary or epistemological boundaries and challenged some relatively narrow assumptions as often-unacknowledged dynamics in the group were made explicit. Anecdotally, such processes seemed to surface 'light-bulb' moments for certain participants and discomfort for others. However, there were also blind spots. More painful or conflictual differences in perspectives between researchers that might truly challenge academic identities and worldviews were left untouched, such as the power dynamics influencing why particular frameworks or methods are chosen or discarded. This was consequential: our approach assumed that researchers had the interest and capacity to carry these learnings with them into their work. In hindsight, we see that many researchers – including some of us in the Reflexivity Task Force – are still motivated to advocate for approaches aligned with our personal scientific agendas.

Despite mixed results for researchers alone, boundary interaction when participants and researchers interacted together seems more fruitful. The co-creation workshop series enabled all of us to see how our perspectives interfaced with others in real time. The reflexivity moments alongside core workshop activities were particularly effective in expanding beyond narrow boundaries and decentring dominant views, as they brought together diverse participants across sectors, geographies and organisations using creative methods and integrative approaches beyond the traditionally narrow boundaries of science. Such processes allowed novel insights to emerge and facilitated the inclusion of diverse forms of knowledge. Despite contrasting views, facilitation approaches largely managed differences productively, maintaining plurality and difference and in

some cases “allowing participants to deconstruct, soften or overcome constraining positions”. The involvement of Indigenous representatives from the Sami community in the second workshop and the outdoor exercise in the third workshop (Figure 3) are noted as among the most successful in drawing out these complexities.

Still, there were limitations to our approach. Highly distinct or conflictual perspectives were sometimes missing. This may be due to workshop and facilitation approaches that focused on delivering project results over participant learning. In such cases, disagreement and deliberation were allowed but not part of the workshop purpose. Participant representation also played a part, wherein participants were selected from researcher networks operating at the European scale who are already aligned to the biodiversity agenda, leading to potential biases and blind spots as more discordant viewpoints were not involved. Additionally, while workshop processes may have facilitated *boundary interaction* in real time, learning may be isolated to the workshop setting and does not necessarily transfer to professional lives and routines.

4.3 Boundary transformation: Learning that altered perspectives

The Reflexivity Task Force appears to have facilitated *boundary transformation* for some researchers and participants. We were particularly effective at creating spaces to expose pluralism and difference through dialogue. As a result, both researchers and stakeholders were encouraged to consider previously unknown or unacknowledged viewpoints, which in some cases challenged, reshaped or broadened their own perspectives. While the aim was mutual learning for both researchers and participants, this learning appeared more significant for participants due to the longer-term, more relational moments in co-creation workshops that allowed participants to grow an understanding and appreciation of each other’s perspectives over time. However, this success is also tied to the co-creation workshop processes beyond reflexivity moments, which aimed to stimulate learning about transformative change.

Individual takeaways reveal some lasting impact of the task force. Participants beyond academia accessed new spaces to listen to and exchange with others and to reflect on their own subjective views that influence their contribution to collective research projects. Some participants and researchers intend to incorporate these insights into their future work. For example, researchers have already used individual methods such as reflexivity booklets in subsequent workshops and plan to “integrate reflexivity into the supervision of PhD students engaged in interdisciplinary research by encouraging structured reflection on assumptions, methods, and positionality.” Others have plans to “more bravely use reflexivity (moments) in my own work/research activities/meetings of the research team” and to place greater emphasis on multiple dimensions of diversity and the mechanisms underpinning transformative change.

Perhaps most importantly, these impacts were limited to those who were actively engaged within the task force, which excluded researchers and stakeholders who were sceptical to begin with or more removed from the co-creation workshop series. We also received feedback that power relations between researchers were under addressed, leaving some feeling underappreciated in their role. Thus, while we have indications of boundary transformation in particular moments for particular people, it remains challenging to discern whether the transformative potential of reflexivity was fully realised.

5. More than a mirror: a call to action to embed reflexivity for transformative sustainability research

This Perspective draws on the experiences of a transdisciplinary experiment: the Reflexivity Task Force, a specialised group of diverse researchers established to embed reflexivity within the BIONEXT project. We show that the interventions of the task force surfaced important insights, prompting important learning. However, there were numerous barriers that limited the transformative potential of our interventions, as in some cases we only partially engaged with the more provocative, power-laden undercurrents influencing transdisciplinary research. These successes and failures inform our reflections on how reflexivity can be embedded within transdisciplinary research in ways that effectively capture its transformative potential.

5.1 Project design should enable deeper and more widespread engagement with reflexivity

Enabling more reflexive and thereby transformative transdisciplinary research requires institutional shifts that embed reflexivity into project design. Our experiences reinforce that even with the best intentions, reflexivity does not simply ‘happen’: it requires leadership, continuity, and adequate time, structure and incentives for researchers across a project consortium to engage (Lang et al., 2012). Changing research practices takes sustained effort and diverse participation with shared commitment among all (Popa et al., 2015), and cannot be achieved through singular events or initiatives involving only those researchers who are already committed to reflexive approaches (Knickel et al., 2019). In the case of BIONEXT, the Reflexivity Task Force was established as a post-proposal addition. While this allowed for experimentation, it also meant we had to advocate for our relevance within the larger project and at times had to deprioritise reflexive activities in favour of core project deliverables. This resulted in missed opportunities for impact that could be enabled if iterative self-scrutiny and mutual learning was directly tied to research outcomes across work packages and partners.

Formally embedding reflexivity in the core project structure and deliverables for large consortium projects like Horizon Europe at the proposal stage would make a significant step. For example, all large transdisciplinary projects could establish a Reflexivity Task Force with specific tasks and deliverables across work packages and partners intended to mediate the biases and power dynamics influencing all processes of knowledge integration. This would help overcome the lack of resources, competition among priorities and institutional settings that limit reflexivity (Ligtermoet et al., 2025; Wyborn et al., 2019) by positioning reflexivity as not only an individual but institutional responsibility (Chakori et al., 2025).

5.2 Broader institutional shifts are required to enable reflexivity at the interface of science and society

Fulfilling the transformative potential of reflexivity not only requires changes in project design: it requires a significant change in the norms and practices of scientific institutions (Loorbach & Wittmayer, 2025). Reflexivity is inherently challenging and will thus meet resistance, as researchers and participants confront the discomfort associated with recognising their own subjectivities in research processes (Hakkarainen & Lazurko, 2025). This points to cycles of inner and outer change that can together shift research attitudes and structures (Goldstein et al., 2025), moving reflexivity from an optional practice to an institutional capacity that supports societal readiness. Rather than treating reflexive activities as peripheral or supplementary, institutions can legitimise and resource

them as integral to research quality, impact, and credibility – particularly in contexts where research is expected to inform policy and societal action under conditions of uncertainty, plurality and contestation (Loorbach & Wittmayer, 2025; Turnhout et al., 2020, Hebinck et al. *in review*).

Concretely, this may involve investing in training and mentoring that support researchers in navigating positionality, power, and uncertainty; adapting incentive and evaluation systems to value learning, care-based collaboration, and reflexive practice alongside conventional outputs; and creating protected spaces and roles within projects and programmes that sustain reflexive capacity over time (Care et al., 2021). Such measures contribute to improved research practice and societal readiness, by strengthening collective capacities to engage with disagreement, ambiguity, and value-related choices as part of transformative change (Fazey et al. 2018; Horcea-Milcu et al. 2024). Without institutional support, reflexivity risks remaining dependent on motivated individuals or exceptional projects, limiting its ability to meaningfully support societal engagement with research-informed pathways.

5.3 Institutionalisation should not neutralise the provocative spirit of reflexivity

Some have argued that reflexivity is only meaningful when something provocative comes of it (Hakkarainen & Lazurko, 2025; Lynch, 2000), and that transformative spaces should be “safe enough” to surface and balance tensions in a generative way (Pereira et al., 2018). We agree with these arguments in principle. However, our reflections on the transformative potential of the Reflexivity Task Force show that we encountered challenges implementing them in practice. We often felt that fully enacting them might alienate us from sceptical researchers, given our position as an optional activity outside core project deliverables. As a result, our activities in some cases failed to address the more uncomfortable but influential undercurrents influencing transdisciplinary research.

We thus accompany calls for institutional shifts to enable reflexivity (Sellberg et al., 2021) with an important caveat. On one hand, formalisation can be important for legitimising reflexivity in the eyes of sceptical researchers and meaningfully connect reflexive interventions to research outcomes. Yet, on the other, there is a risk that institutionalising reflexivity neutralises its provocative spirit, as it is reshaped to align within the very norms, ideologies and power structures that it is meant to challenge (Turnhout et al., 2026). In other words, reflexivity risks remaining a mirror, enabling reflection about known biases without surfacing and mediating blind spots and power dynamics in ways that meaningfully disrupt the status quo. Navigating this challenge requires taking onboard recommendations for the institutional shifts required for transformative research (Horcea-Milcu et al., 2024), while nurturing a different set of skills, competencies and priorities than those taught and incentivised in research.

First, it requires creating a sense of psychological safety (Edmondson & Lei, 2014) through empathy and active listening. The Reflexivity Task Force emerged from a shared set of values, underpinned by assumptions that reflexivity is important, worthwhile and impactful. While members of the task force sometimes disagreed on particular interventions, we always came back to this shared purpose. However, engagement with the wider project consortium revealed that some researchers were unfamiliar with the concepts and language we used, feared that extensive self-scrutiny and critique might undermine scientific credibility, or were sceptical about the value of engaging with abstract or difficult-to-resolve questions. Future efforts to embed reflexivity would benefit from starting with empathetic and active listening in formal and informal settings to understand how researchers see themselves, how they relate to ideas of change-making, and what beliefs and values underpin their research practice. This can help build trust and a clear and inclusive purpose that recognises diverse purposes on the ‘why’ of reflexivity, moving beyond concerns that critique may undermine scientific

credibility to reframe reflexive interventions as contributing to rigorous, trustworthy and impactful research.

Second, it requires researchers to have the skills, bravery and institutional support required to be provocative, to push past sceptical or unsupportive responses by aligning to a higher purpose that “a better knowledge is possible” (Turnhout, 2024). The interventions of the Reflexivity Task Force emerged out of our own deliberations, in which we often discussed whether to tone down our approach to avoid language or activities that might be too confrontational for researchers and participants. In some cases, our shared values and purpose created our own blindspots, wherein we inadvertently neutralised the discussions despite our explicit desire to activate deeper learning. This speaks to the need to attend to the emotional experiences of the task force and the wider project consortium, with the help of an external facilitator or arts-based creative methods (Galafassi et al., 2018; Prall & Ounanian, 2026), to engage carefully with the fear associated with confronting more painful biases and power dynamics influencing research. It also speaks to the need to institutionalise provocation in ways that provide safety for researchers, such as mandating task forces like ours to have external chairs to ask tougher questions and legitimise the rationale and methods for reflexivity, or to provide budgets for activities of the task force that support transformative learning as a key outcome.

Finally, institutionalisation of reflexivity must maintain a flexible, iterative, and emergent approach (Basta et al., 2021; Popa et al., 2015). There is no one-size-fits-all approach to embedding reflexivity, particularly given the messy nature of transdisciplinarity (Regeer et al., 2024). Our reflexive interventions in BIONEXT emerged through a combination of project opportunities, constraints, and our own learning processes. Each attempt to stimulate reflexivity prompted us to revisit our own assumptions and refine our approaches, enabling new interventions that would speak to the needs of the research project. Aligning reflexivity to project structure and deliverables must thus provide “just enough structure” (Regeer et al., 2024) to offer the motivation and context within which to steward reflexivity, without dictating exactly how and with what outcomes and while leaving room for both informal and formal modes of engagement. Importantly, to enable this kind of emergent learning, we need the transdisciplinary research community to develop repositories of reflexive interventions (e.g., as cited in (Ligtermoet et al., 2025) that could be adapted to new contexts and experiences, contributing to a shared agenda for developing context-specific and inclusive reflexive practices.

5.4 Toward reflexive transdisciplinary sustainability research

Looking ahead, our learnings point to opportunities to make reflexivity more than a mirror, instead embedded as a foundational condition of a transformative science-policy-society interface and, by extension, societal readiness. As research programmes such as Horizon Europe increasingly position projects as contributors to societal transformation, reflexivity becomes central to ensuring that interactions between science, policy, and society remain open to plurality, critical engagement, and mutual learning. In this sense, reflexivity supports not only more inclusive collaboration within projects, but also the preparedness of societal actors to engage with transformative pathways, negotiate differing values, and respond to emerging knowledge and uncertainties. Embedding reflexivity at this interface requires moving beyond assessment-oriented models of science-policy interaction toward configurations that enable experimentation, learning-by-doing, and reciprocal and provocative feedback between research, policy and societal practice. Reflexivity thus functions as an enabling infrastructure for societal readiness: grounding transformative ambitions in lived practice, challenging convergence around dominant framings, and strengthening legitimacy, adaptability, and responsiveness of research-informed action in complex sustainability contexts.

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References

- Augenstein, K., Lam, D. P. M., Horcea-Milcu, A.-I., Bernert, P., Charli-Joseph, L., Cockburn, J., Kampfmann, T., Pereira, L. M., & Sellberg, M. M. (2024). Five priorities to advance transformative transdisciplinary research. *Current Opinion in Environmental Sustainability*, 68, 101438. <https://doi.org/https://doi.org/10.1016/j.cosust.2024.101438>
- Basta, C., Kunseler, E., Wamsler, C., van der Jagt, A., Baró, F., Balenciaga, I., Bach, M., & Wickenberg, B. (2021). Inclusiveness, Equity, Consistency, and Flexibility as Guiding Criteria for Enabling Transdisciplinary Collaboration: Lessons From a European Project on Nature-Based Solutions and Urban Innovation. *Frontiers in Climate, Volume 3-2021*. <https://www.frontiersin.org/journals/climate/articles/10.3389/fclim.2021.630075>
- Bernstein, M. J., Nielsen, M. W., Alnor, E., Brasil, A., Birkving, A. L., Chan, T. T., Griessler, E., de Jong, S., van de Klippe, W., Meijer, I., Yaghmaei, E., Nicolaisen, P. B., Nieminen, M., Novitzky, P., & Mejlgaard, N. (2022). The Societal Readiness Thinking Tool: A Practical Resource for Maturing the Societal Readiness of Research Projects. *Science and Engineering Ethics*, 28(1), 6. <https://doi.org/10.1007/s11948-021-00360-3>
- Borie, M., Mahony, M., Obermeister, N., & Hulme, M. (2021). Knowing like a global expert organization: Comparative insights from the IPCC and IPBES. *Global Environmental Change*, 68, 102261. <https://doi.org/10.1016/j.gloenvcha.2021.102261>
- Bornemann, B., & Christen, M. (2020). Navigating between Complexity and Control in Transdisciplinary Problem Framing: Meaning Making as an Approach to Reflexive Integration. *Social Epistemology*, 34(4), 357–369. <https://doi.org/10.1080/02691728.2019.1706120>
- Braun, R., Bernstein, M. J., Chakraborty, A., Starkbaum, J., & Winkler, F. (2025). Societal Readiness Thinking Process 2.0: Incorporating Epistemic Reflexivity for Responsible Innovation. *Science and Engineering Ethics*, 31(6), 42. <https://doi.org/10.1007/s11948-025-00568-7>
- Caniglia, G., Luederitz, C., von Wirth, T., Fazey, I., Martín-López, B., Hondrila, K., König, A., von Wehrden, H., Schäpke, N. A., Laubichler, M. D., & Lang, D. J. (2020). A pluralistic and integrated approach to action-oriented knowledge for sustainability. *Nature Sustainability*, 4(2), 93–100. <https://doi.org/10.1038/s41893-020-00616-z>
- Care, O., Bernstein, M. J., Chapman, M., Diaz Reviriego, I., Dressler, G., Felipe-Lucia, M. R., Friis, C., Graham, S., Hänke, H., Haider, L. J., Hernández-Morcillo, M., Hoffmann, H., Kernecker, M., Nicol, P., Piñeiro, C., Pitt, H., Schill, C., Seufert, V., Shu, K., ... Zaehring, J. G. (2021). Creating leadership collectives for sustainability transformations. *Sustainability Science*, 16(2), 703–708. <https://doi.org/10.1007/s11625-021-00909-y>
- Chakori, S., Grigg, N. J., Biely, K., Szetey, K., Dunlop, M., Gorddard, R., & Hopkinson, S. (2025). Advancing strong sustainability in transdisciplinary research: Opportunities, barriers, and strategies. *Earth Stewardship*, 2(4), e70023. <https://doi.org/10.1002/eas2.70023>
- Chambers, J. M., Wyborn, C., Klenk, N. L., Ryan, M., Serban, A., Bennett, N. J., Brennan, R., Charli-Joseph, L., Fernández-Giménez, M. E., Galvin, K. A., Goldstein, B. E., Haller, T., Hill, R., Munera, C., Nel, J. L., Österblom, H., Reid, R. S., Riechers, M., Spierenburg, M., ... Rondeau, R. (2022). Co-productive agility and four collaborative pathways to sustainability transformations. *Global Environmental Change*, 72, 102422. <https://doi.org/https://doi.org/10.1016/j.gloenvcha.2021.102422>

- Chilisa, B. (2017). Decolonising transdisciplinary research approaches: An African perspective for enhancing knowledge integration in sustainability science. *Sustainability Science*, 12(5), 813–827. <https://doi.org/10.1007/s11625-017-0461-1>
- Cockburn, J. (2022). Knowledge integration in transdisciplinary sustainability science: Tools from applied critical realism. *Sustainable Development*, 30(2), 358–374. <https://doi.org/10.1002/sd.2279>
- Cockburn, J., & Cundill, G. (2018). Ethics in transdisciplinary research: Reflections on the implications of ‘science with society’. In C. Macleod, C. Marx, J. Mnyaka, & Trehardne G.J. (Eds), *Handbook of ethics in critical research: Stories from the field*.
- Edmondson, A. C., & Lei, Z. (2014). Psychological Safety: The History, Renaissance, and Future of an Interpersonal Construct. In *Annual Review of Organizational Psychology and Organizational Behavior* (Vol. 1, Issue Volume 1, 2014, pp. 23–43). Annual Reviews. <https://doi.org/https://doi.org/10.1146/annurev-orgpsych-031413-091305>
- Fazey, I., Schäpke, N., Caniglia, G., Hodgson, A., Kendrick, I., Lyon, C., Page, G., Patterson, J., Riedy, C., Strasser, T., Verveen, S., Adams, D., Goldstein, B., Klaes, M., Leicester, G., Linyard, A., McCurdy, A., Ryan, P., Sharpe, B., ... Young, H. R. (2020). Transforming knowledge systems for life on Earth: Visions of future systems and how to get there. *Energy Research & Social Science*, 70, 101724. <https://doi.org/https://doi.org/10.1016/j.erss.2020.101724>
- Francis, B., Schepers, T., Porcari, A., & Brey, P. (2026). A societal readiness tool for responsible product innovation. *Technology in Society*, 85, 103183. <https://doi.org/10.1016/j.techsoc.2025.103183>
- Fritz, L., Burkhart, S., & Schneider, F. (2026). Power in Transdisciplinary Sustainability Research: Theories, Manifestations, and Navigation Strategies. *Annual Review of Environment and Resources*. <https://doi.org/https://doi.org/10.1146/annurev-environ-112923-100153>
- Galafassi, D., Kagan, S., Milkoreit, M., Heras, M., Bilodeau, C., Bourke, S. J., Merrie, A., Guerrero, L., Pétursdóttir, G., & Tàbara, J. D. (2018). ‘Raising the temperature’: The arts in a warming planet. *Current Opinion in Environmental Sustainability*, 31(2), 71–79. <https://doi.org/10.1016/j.cosust.2017.12.010>
- Goldstein, B. E., Manuel-Navarrete, D., & Schaepeke, N. (2025). Transformative Earth Stewardship: Navigating cycles of inner and outer change. *Earth Stewardship*, 2(4), e70024. <https://doi.org/10.1002/eas2.70024>
- Gregory, W. J. (1996). Discordant pluralism: A new strategy for critical systems thinking. *Systems Practice*, 9(6), 605–625. <https://doi.org/10.1007/BF02169216>
- Haider, L. J., Hentati-Sundberg, J., Giusti, M., Goodness, J., Hamann, M., Masterson, V. A., Meacham, M., Merrie, A., Ospina, D., Schill, C., & Sinare, H. (2018). The undisciplinary journey: Early-career perspectives in sustainability science. *Sustainability Science*, 13(1), 191–204. <https://doi.org/10.1007/s11625-017-0445-1>
- Haider, L. J., & Rieser, J. “Präa S. (2025). From reflexive co-production to diffractive co-becoming: Insights from new materialism for sustainability sciences. *Humanities and Social Sciences Communications*, 12(1), 787. <https://doi.org/10.1057/s41599-025-05101-6>

- 795 Hakkarainen, V., & Lazurko, A. (2025). Entanglements of knowledge and action in sustainability
796 science: Reclaiming reflexivity to embrace the uncomfortable. *Sustainability Science*, 20(5), 1979–
797 1990. <https://doi.org/10.1007/s11625-025-01717-4>
- 798 Hertz, T., & Schlüter, M. (2015). The SES-Framework as boundary object to address theory orientation
799 in social–ecological system research: The SES-TheOr approach. *Ecological Economics*, 116, 12–24.
800 <https://doi.org/https://doi.org/10.1016/j.ecolecon.2015.03.022>
- 801 Horcea-Milcu, A.-I., Dorresteyn, I., Leventon, J., Stojanovic, M., Lam, D. P. M., Lang, D. J., Moriggi, A.,
802 Raymond, C. M., Stålhammar, S., Weiser, A., & Zimmermann, S. (2024). Transformative research for
803 sustainability: Characteristics, tensions, and moving forward. *Global Sustainability*, 7, e14.
804 <https://doi.org/DOI:%2010.1017/sus.2024.12>
- 805 Hubeau, M., Marchand, F., Coteur, I., Debruyne, L., & Van Huylenbroeck, G. (2018). A reflexive
806 assessment of a regional initiative in the agri-food system to test whether and how it meets the
807 premises of transdisciplinary research. *Sustainability Science*, 13(4), 1137–1154.
808 <https://doi.org/10.1007/s11625-017-0514-5>
- 809 IPBES. (2024). *Summary for Policymakers of the Thematic Assessment Report on the Underlying*
810 *Causes of Biodiversity Loss and the Determinants of Transformative Change and Options for*
811 *Achieving the 2050 Vision for Biodiversity of the Intergovernmental Science-Policy Platform on*
812 *Biodiversity and Ecosystem Services* (K. O'Brien, L. Garibaldi, A. Agrawal, E. Bennett, O. Biggs, R.
813 Calderon Contreras, E. Carr, N. Frantzeskaki, H. Gosnell, J. Gurung, S. Lambertucci, J. Leventon, C.
814 Liao, V. Reyes Garcia, L. Shannon, S. Villasante, F. Wickson, Y. Zinngrebe, & L. Perianin, Eds). IPBES
815 secretariat. <https://doi.org/10.5281/zenodo.3553458>
- 816 Knickel, M., Knickel, K., Galli, F., Maye, D., & Wiskerke, J. S. C. (2019). Towards a reflexive framework
817 for fostering co-learning and improvement of transdisciplinary collaboration. *Sustainability*
818 *(Switzerland)*, 11(23), 6–8. <https://doi.org/10.3390/su11236602>
- 819 Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., & Thomas, C. J.
820 (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges.
821 *Sustainability Science*, 7(1), 25–43. <https://doi.org/10.1007/s11625-011-0149-x>
- 822 Lazurko, A., Haider, L. J., Hertz, T., West, S., & McCarthy, D. D. P. (2024). Operationalizing ambiguity in
823 sustainability science: Embracing the elephant in the room. *Sustainability Science*, 19(2), 595–614.
824 <https://doi.org/10.1007/s11625-023-01446-6>
- 825 Lazurko, A., Moore, M.-L., Haider, L. J., West, S., & McCarthy, D. D. P. (2025). Reflexivity as a
826 transformative capacity for sustainability science: Introducing a critical systems approach. *Global*
827 *Sustainability*, 8, e1. <https://doi.org/DOI:%2010.1017/sus.2024.49>
- 828 Ligtermoet, E., Munera-Roldan, C., Robinson, C., Sushil, Z., & Leith, P. (2025). Preparing for
829 knowledge co-production: A diagnostic approach to foster reflexivity for interdisciplinary research
830 teams. *Humanities and Social Sciences Communications*, 12(1), 257. <https://doi.org/10.1057/s41599-024-04196-7>
- 832 Loorbach, D., & Wittmayer, J. M. (2025). Transformative Tensions in the Ivory Tower. *Minerva*.
833 <https://doi.org/10.1007/s11024-025-09607-w>
- 834 Lynch, M. (2000). Against Reflexivity as an Academic Virtue and Source of Privileged Knowledge.
835 *Theory, Culture & Society*, 17(3), 26–54. <https://doi.org/10.1177/02632760022051202>

- Martin, D. H. (2012). Two-eyed seeing: A framework for Indigenous approaches to Indigenous health research. *Canadian Journal of Nursing Research*, 44(2), 20–42.
- McIntyre, D. G., Cloutis, G. A., & McCarthy, D. (2023). Indigenous trans-systemics: Changing the volume on systems. *Sustainability Science*, 18(4), 1961–1975. <https://doi.org/10.1007/s11625-023-01330-3>
- Mitchell, C., Cordell, D., & Fam, D. (2015). Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research. *Futures*, 65, 86–96. <https://doi.org/10.1016/j.futures.2014.10.007>
- Pereira, L. M., Karpouzoglou, T., Frantzeskaki, N., & Olsson, P. (2018). Designing transformative spaces for sustainability in social-ecological. *Ecology and Society*, 23(4), 32.
- Popa, F., Guillermin, M., & Dedeurwaerdere, T. (2015). A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures*, 65, 45–56. <https://doi.org/10.1016/j.futures.2014.02.002>
- Prall, M. C., & Ounanian, K. (2026). Arts-based methods for just co-creation of sustainable futures. *Futures*, 182, 103869. <https://doi.org/10.1016/j.futures.2026.103869>
- Reed, M. G., Robson, J. P., Campos Rivera, M., Chapela, F., Davidson-Hunt, I., Friedrichsen, P., Haine, E., Johnston, A. B. D., Lichtenstein, G., Lynes, L. S., Oloko, M., Sánchez Luja, M., Shackleton, S., Soriano, M., Sosa Pérez, F., & Vasseur, L. (2023). Guiding principles for transdisciplinary sustainability research and practice. *People and Nature*, 5(4), 1094–1109. <https://doi.org/10.1002/pan3.10496>
- Regeer, B. J., Kok, K. P. W., Lux, A., Lang, D. J., & van Mierlo, B. (2024). Structuring Design & Evaluation in Transdisciplinarity for Transformation. In B. J. Regeer, P. Klaassen, & J. E. W. Broerse (Eds), *Transdisciplinarity for Transformation: Responding to Societal Challenges through Multi-actor, Reflexive Practices* (pp. 79–110). Springer International Publishing. https://doi.org/10.1007/978-3-031-60974-9_3
- Sellberg, M. M., Cockburn, J., Holden, P. B., & Lam, D. P. M. (2021). Towards a caring transdisciplinary research practice: Navigating science, society and self. *Ecosystems and People*, 17(1), 292–305. <https://doi.org/10.1080/26395916.2021.1931452>
- Staffa, R. K., Riechers, M., & Martín-López, B. (2022). A feminist ethos for caring knowledge production in transdisciplinary sustainability science. *Sustainability Science*, 17(1), 45–63. <https://doi.org/10.1007/s11625-021-01064-0>
- Strang, V. (2009). Integrating the social and natural sciences in environmental research: A discussion paper. *Environment, Development and Sustainability*, 11(1), 1–18. <https://doi.org/10.1007/s10668-007-9095-2>
- Tengö, M., Brondizio, E. S., Elmqvist, T., Malmer, P., & Spierenburg, M. (2014). Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. *AMBIO*, 43(5), 579–591. <https://doi.org/10.1007/s13280-014-0501-3>
- Turnhout, E. (2019). Interdisciplinarity and the Challenge of Knowledge Integration. In *Environmental Expertise: Connecting Science, Policy, and Society* (pp. 152–164). <https://doi.org/10.1017/9781316162514.013>

- 875 Turnhout, E. (2024). A better knowledge is possible: Transforming environmental science for justice
876 and pluralism. *Environmental Science & Policy*, 155, 103729.
877 <https://doi.org/https://doi.org/10.1016/j.envsci.2024.103729>
- 878 Turnhout, E., Bridgewater, P., Chambers, J., Forsyth, T., Huang, Q., Leventon, J., Linnér, B.-O., Mehta,
879 L., Nelson, V., Raab, K., Reyes-García, V., Sabinot, C., & Stokland, H. B. (2026). Knowing and
880 unknowing transformative change: Epistemic inequities and epistemic justice in the IPBES
881 transformative change assessment. *Environmental Science & Policy*, 182, 104434.
882 <https://doi.org/10.1016/j.envsci.2026.104434>
- 883 Turnhout, E., Metze, T., Wyborn, C., Klenk, N., & Louder, E. (2020). The politics of co-production:
884 Participation, power, and transformation. *Current Opinion in Environmental Sustainability*, 42, 15–21.
885 <https://doi.org/10.1016/j.cosust.2019.11.009>
- 886 Ulrich, W. (2003). Beyond methodology choice: Critical systems thinking as critically systemic
887 discourse. *Journal of the Operational Research Society*, 54(4), 325–342.
888 <https://doi.org/10.1057/palgrave.jors.2601518>
- 889 von Seggern, J., Holst, J., & Singer-Brodowski, M. (2023). The self in the mirror: Fostering researchers'
890 reflexivity in transdisciplinary and transformative studies at the science-policy interface. *Ecology and*
891 *Society*, 28(2). <https://doi.org/10.5751/ES-14057-280217>
- 892 West, S., van Kerkhoff, L., & Wagenaar, H. (2019). Beyond “linking knowledge and action”: Towards a
893 practice-based approach to transdisciplinary sustainability interventions. *Policy Studies*, 40(5), 534–
894 555. <https://doi.org/10.1080/01442872.2019.1618810>
- 895 Wiegleb, V., & Bruns, A. (2023). Working the boundary: Science–policy interactions and uneven
896 knowledge politics in IPBES. *Sustainability Science*, 18(3), 1069–1084.
897 <https://doi.org/10.1007/s11625-022-01238-4>
- 898 Wyborn, C., Datta, A., Montana, J., Ryan, M., Leith, P., Chaffin, B., Miller, C., & van Kerkhoff, L. (2019).
899 Co-Producing Sustainability: Reordering the Governance of Science, Policy, and Practice. In *Annual*
900 *Review of Environment and Resources* (Vol. 44, Issue Volume 44, 2019, pp. 319–346). Annual
901 Reviews. <https://doi.org/https://doi.org/10.1146/annurev-environ-101718-033103>
- 902 Wyborn, C., Montana, J., Kalas, N., Clement, S., Davila, F., Knowles, N., Louder, E., Balan, M.,
903 Chambers, J., Christel, L., Forsyth, T., Henderson, G., Izquierdo Tort, S., Lim, M., Martinez-Harms, M.
904 J., Merçon, J., Nuesiri, E., Pereira, L., Pilbeam, V., ... Ryan, M. (2021). An agenda for research and
905 action toward diverse and just futures for life on Earth. *Conservation Biology*, 35(4), 1086–1097.
906 <https://doi.org/10.1111/cobi.13671>
- 907
- 908