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Advancing strong sustainability in transdisciplinary research: Opportunities, barriers, and strategies

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Abstract

Transdisciplinary approaches emphasize the need to engage with diverse actors to co-produce knowledge and enable societal change to address interlinked socio-ecological crises. This paper investigates how transdisciplinary partnerships can better work with strong sustainability perspectives, especially in contexts where actors hold differing worldviews. We explore the tension between transdisciplinary approaches and sustainability discourses. We begin by presenting the often contentious and divergent perspectives on strong and weak sustainability discourses, stressing that preferential engagement with weak sustainability approaches risks undermining strong sustainability transitions. Based on insights from reflexive practice on three research projects and the outcomes of a conference workshop, this article presents 12 strategies used to address common barriers to engaging with strong sustainability. These include researchers socializing new narratives (e.g., degrowth) and facilitating safe spaces to deliberate and explore societal mental models and paradigms. The findings underscore the political nature of knowledge production and stress the benefits of reflexivity at both individual and institutional levels. Reflecting on the politics of knowledge is not only an intellectual exercise, positionalities and interests of researchers and/or their organisations affect research agendas and resources. This research contributes to advancing sustainability transitions by highlighting strategies for questioning and challenging dominant economic and political systems within transdisciplinary partnerships, opening opportunities for deeper transitions toward more equitable and sustainable futures.

KEYWORDS
co-production, degrowth, interdisciplinarity, plurality, sustainability, transdisciplinary research

INTRODUCTION

In sustainability transition research, the term "sustainability" is often treated as an implicit concept about which there is broad agreement (Feola, 2020). However, as Feola (2020) noted, divergent interpretations of "sustainability" entail different ambitions and transition pathways. The choice of sustainability concepts, goals, and methodologies profoundly influences our approach to understanding, exploring, implementing, and evaluating change. Interlinked socio-ecological crises are characterized and addressed differently within these varying sustainability discourses. Furthermore, while certain sustainability approaches are easily integrated into contemporary societal frameworks, others encounter resistance, particularly when they challenge existing paradigms. As presented in this study, As presented in this study, in the next section, *Strong sustainability characterisation: engagement with the capitalist growth-driven system*, it is important to clarify these discourses given worsening indicators of planetary health, including climate change, biodiversity loss, water pollution, and widening social and economic inequalities (IPCC, 2022; IPCC, 2023). There is an urgency to act to solve these socio-ecological challenges. Therefore, there is a need to shift from weak sustainability approaches toward strong sustainability ones. This study draws on established characterizations of "strong" sustainability (Ang & Van Passel, 2012; Biely & Chakori, 2025; Daly, 1995; Morrison et al., 2022; Ruggerio, 2021) and investigates means for facilitating engagement with strong sustainability perspectives within transdisciplinary partnerships, especially in contexts where actors hold different worldviews or experience barriers to including these perspectives.

Progress in translating scientific knowledge on sustainability into tangible outcomes can be slow or ineffective (Stoddard et al., 2021). In this context, transdisciplinary methods (i.e., co-production of knowledge and actions) have gained attention (Preston et al., 2015; Wyborn et al., 2019), emphasizing co-production processes that engage diverse actors and researchers to work collaboratively and iteratively to produce knowledge, actions, and societal changes that enable sustainable transformations (Chambers et al., 2022; Wyborn et al., 2019). While transdisciplinary approaches can be applied in various domains, the focus here is to consider them in the sustainability context. The complex interactions between research, policy, politics, and society have attracted great interest in sustainability research (Wyborn et al., 2019). Transdisciplinary approaches emphasize the value of working with diverse actors with different forms of knowledge and agency in the system. Engaging with their interests and needs to co-produce options and pathways creates a means for research knowledge to bring about effective change (Chambers et al., 2022).

To facilitate change, transdisciplinary practices require researchers to engage with different actors and views (Chambers et al., 2022; Wyborn et al., 2019). Thus, this study explores tensions associated with bringing strong sustainability framings to transdisciplinary settings, especially when actors hold different perspectives and worldviews or face barriers to engaging with strong sustainability goals and principles. How can sustainability researchers and practitioners foster constructive engagement with strong sustainability perspectives in transdisciplinary projects while collaborating with partners who resist doing so? Managing this tension in sustainability transitions work becomes even more relevant if researchers (and practitioners) aim to shift from research *about* sustainability, which generates knowledge without attempting to guide any implementation, to research *for* sustainability, which entails seeking to generate knowledge while facilitating transformative change (Preston et al., 2015). The politics of knowledge in this context exerts a strong influence: "engaging with a diversity of contexts or a plurality of perspectives is always deeply political. Negotiations among contending knowledges and divergent interests across multiple actors inevitably involve politics: confronting disparate views, interests and forms of incumbent power. Wider political institutions, economic systems and technical infrastructures inevitably shape what happens and what might be possible" (Scoones et al., 2018, p. 11). Thus, this paper seeks to identify strategies for incorporating strong sustainability perspectives into transdisciplinary research despite institutional and stakeholder resistance.

This paper is part of a special issue of the Transformations Conference (Sydney, 2023). The conference created an opportunity to reflect on these questions in a dedicated session with researchers and practitioners interested in transformation. The next section, *Strong sustainability characterisation: engagement with the capitalist growth-driven system* characterizes elements of strong sustainability. *Methods* outline the methods used in the conference session and case reflections. The findings of these activities are presented in *Results*, including a set of strategies for incorporating strong sustainability approaches in transdisciplinary research. *Discussion* presents a further discussion of findings and strategies. *Conclusion* concludes by emphasizing the need to pay attention to the politics of knowledge and reflexivity at individual and institutional levels.

STRONG SUSTAINABILITY CHARACTERIZATION: ENGAGEMENT WITH THE CAPITALIST GROWTH-DRIVEN SYSTEM

Global assessments continue documenting ongoing increases in atmospheric greenhouse gas concentrations, declining biodiversity, increasing production, release, and impacts of "novel entities" (e.g., plastics, pollutants), increasing land system change and alteration of freshwater cycles, and the adverse impacts associated with these changes (IPCC, 2023; UNEP, 2024). Yet, the system shows high resistance to change, and the window of opportunity to implement action to curb the negative effects is closing.

Sustainability can be "ill-defined, not defined or contradictorily defined" (Partidario et al., 2010, p. 2852). Differences in sustainability understandings and practices result in divergent socio-economic transition ambitions and actions (Kaul et al., 2022). This paper focuses on the value of transdisciplinary research endeavors explicitly including "strong sustainability" perspectives and approaches that recognize and address this resistance.

We build on existing characterizations of weak and strong sustainability science (Ang & Van Passel, 2012; Biely & Chakori, 2025; Daly, 1995; Morrison et al., 2022; Ruggerio, 2021), with a primary emphasis on the key distinction that strong sustainability transitions require the political and economic system to be in scope for analysis and change. Too often, sustainability transition research neglects to engage with the dominant organizing socio-economic system: the growth-driven capitalist system (Feola, 2020). Yet, there are multiple dimensions to strong sustainability. For example, strong sustainability approaches acknowledge the incommensurability between natural capital and human-made capital, and recognize the intrinsic values of nature (i.e., an ecocentric perspective) (Ang & Van Passel, 2012; Chiesura & De Groot, 2003; Daly, 1995). The needs of all species and ecological systems are considered beyond anthropocentric perspectives. Nature is recognized for providing diverse contributions (not limited to economic benefits) to people (Pereira et al., 2020). These perspectives contrast with weak sustainability perspectives, where instrumental contributions from nature are mainly recognized in the form of commodified products and valued only to the extent that they contribute to economic growth (i.e., marketization and privatization of nature and its products—the neoliberalization of nature) (Riedy, 2020; Wanner, 2015). Although these aspects highlight some critical differences, this study considers the deeper ground that underpins these divergent perspectives.

Exploring strong sustainability, by including a critical analysis of the political and economic system, is fundamental to understanding and addressing the root causes of the socio-ecological crisis. Moore (2017, p. 621) suggests that, to understand the ecological crisis and to have "a fruitful debate over the entangled questions of the origins of planetary crisis," more systemic options for enabling change are revealed by recognizing that the current socio-economic crisis is happening under the *Capitalocene*, the historical era shaped by the limitless pursuit of accumulation of capital (Moore, 2017). In the Capitalocene, nature, food, labor, and energy are commodified and exploited (Moore, 2017). Avoiding engagement with the driving forces of the capitalist growth-driven system could impede tackling the systemic barriers of sustainability transitions (Morrison et al., 2022). Strong sustainability lenses create additional opportunities to analyze and tackle these barriers. A serious analytical examination of sustainability transitions is severely limited if the growth-driven system is considered an unchangeable given (Feola, 2020). Morrison et al. (2022) proposed a spectrum of sustainability transitions where, for example, technological-based solutions (e.g., unproven technologies such as carbon capture and storage) are considered "palliative" transitions and market-based ones (e.g., nature markets and accounting schemes) are categorized as "hopeful" transitions, while at the opposite "deep transitions" end of the spectrum, are those aiming to question, challenge, and transform capitalist, exploitative and extractive systems through tackling asymmetrical power relations, unraveling exploitative and extractive systems, and enabling degrowth pathways. We use "strong sustainability" to refer to the "deep transitions" end of the Morrison et al. (2022) spectrum.

Contrary to weak sustainability, which mainly focuses on technocentric approaches (Biely & Chakori, 2025), strong sustainability emphasizes the need to advance just transitions. Just transitions go beyond environmental concerns (and technological responses) and seek to restructure economies to improve, for example, democratization, distribution of resources, responsibilities for environmental damages, and many other aspects (Godin et al., 2022). Moreover, engaging in strong sustainability framings means also engaging with social aspects, such as gender and race considerations (Salleh, 2009). Feminist and postcolonial literature emphasizes the value of recognizing social debts (i.e., debts owed by capitalist employers for surplus value extracted from the laboring bodies and minds of industrial, service, and enslaved workers), ecological debt (i.e., owed by the global North to the South for direct extraction of the natural means of production or livelihood of nonindustrial people), and embodied debt (i.e., owed to unpaid

reproductive workers who provide use values and regenerate the conditions of production, including the future labor force of capitalism) (Salleh, 2009). For example, the "clean" energy transition can be explored using the social, ecological, and embodied debt lenses. Dominant ecomodernist strategies, which are aligned with weak sustainability approaches (Biely & Chakori, 2025), might perpetuate enclosure (e.g., capture of resources, "green grabbing," accumulation by decarbonization), exclusion (e.g., unfair planning, accumulation by dispossession), encroachment (e.g., destruction of the environment, profit-driven nature-based markets), or entrenchment (e.g., worsening of inequality or vulnerability, elite capture) (Sovacool, 2021). Issues of power and vulnerability have largely been avoided in research on energy and sustainability transitions (Geels, 2014; Sovacool, 2021), but sustainability transitions that overlook the social, ecological, and embodied debts risk exacerbating well-documented social and environmental problems. Acting as though race, gender, and class are invisible in sustainability transitions favors the status quo. Including these aspects as part of strong sustainability, transitions create the opportunity to challenge conventional historical accounts of, for example, energy transitions, which privilege the role of technology and innovation. All these aspects warrant inclusion if the objective is for a just transition.

We have sketched some problematic aspects of the "clean" energy transition. However, this is only one example of a more systemic phenomenon. Due to the systemic nature of the growth-driven system in place, vulnerable countries and communities are often under threat from multiple pressures (e.g., the threat of land grabbing for carbon offset markets, biofuel production, and solar energy infrastructure) (Sovacool, 2021). Carbon trading schemes, biodiversity offsets markets, and payment for ecosystem services offer other examples of cases where social, ecological, and embodied debts risk being neglected so contributing to weak rather than strong sustainability outcomes. For instance, biodiversity becomes another productive asset used to generate profits, often at the expense of other societal goals, such as protecting the sovereignty of Indigenous and rural communities (Sovacool, 2021). These market-based mechanisms are promoted as a strategy able to achieve economic gains (profits) while attaining environmental goals. Yet, several critiques exist, which include concerns about intrinsic conservation efforts and distributive justice (Gómez-Baggethun & Muradian, 2015). These markets risk exacerbating the crisis even further by "normalising the dispossession and expendability of historically oppressed communities, while simultaneously promoting exclusive landscapes, infrastructures, and policies for privileged populations" (Rice et al., 2022, p. 626). As a result, livelihoods and culture will continue to be at the mercy of growth-driven goals. These examples demonstrate existing concerns with weak sustainability approaches (i.e., "green" growth), which can constitute another form of co-option that neutralizes "counter-hegemonic challenges to neoliberal capitalism and its entrenched interests, such as arguments about limits to economic growth based on environmental grounds and the earth's limited carrying capacity" (Wanner, 2015, p. 23).

Strong sustainability, advanced by fields such as ecological, feminist, and postcolonial economics, social-ecological systems, degrowth and steady-state economics, buen vivir, and many others, engages with and challenges the growth-driven discourse (Daly, 1995; O'Neill, 2012; Salleh, 2009). For example, in the sustainability spectrum proposed by Morrison et al. (2022), degrowth appeared as a strong sustainability pathway. Degrowth has become a central field of study investigating alternatives to the growth-driven socio-economic system (Hickel et al., 2021). Degrowth can be defined as a multidimensional concept that aims at "an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global level, in the short and long-term" (Schneider et al., 2010, p. 512). Thus, degrowth aims to explore a reconfiguration of society that could lead to social and ecological well-being within planetary boundaries, a possible pathway toward a steady-state economy (O'Neill, 2012). Degrowth embodies the definition of strong sustainability because it is a multidimensional transition aiming to establish values and objectives distinct from those that nurture economic growth (Hickel et al., 2021).

In the rest of the study, we explore and discuss how strong sustainability dimensions could be (better) integrated into transdisciplinary practices. Yet, it is important to highlight that while the literature on strong and weak sustainability offers various definitions, sustainability science, and transitions remain complex. While some approaches (e.g., limited to fostering technological advances within a capitalist system) clearly reinforce weak approaches, in other cases, shades of different sustainability approaches can exist. In the following sections, we discuss that, in some instances, it is too simplistic to define projects simply as focusing on strong or weak sustainability. Therefore, having a clear understanding of the differences between the two ends of the spectrum can help remain vigilant and assess projects to foster stronger sustainability approaches.

METHODS

To explore the question of this study, we reflected on strategies adopted in our practice to facilitate the

inclusion of strong sustainability (see *Reflexivity on research projects*). Additionally, we explored the same matter with conference participants during a workshop at the Transformations Conference (Australia, 2023) (see *Workshop*), some of whom joined as co-authors or made other acknowledged contributions to this paper.

The first two authors of this study began by reflecting on and analyzing the first research case, adopting reflexivity approaches as explained below. In a second stage, the authors explored the question of this study with participants of the Transformations Conference. To enrich the analysis, the authors included the second and third cases, which included relevant strategies for engaging with transformational change in transdisciplinary partnerships. This article was submitted to a special issue linked to the conference, and it relates to the special issue questions: "How does the diversity of knowledge, perspectives, cultures, disciplines, and narratives contribute to sustainability transformations? How can we build coalitions that respect diversity while pursuing sustainability transformations?"

The strategies adopted in our practice and resulting from the consultation with the workshop participants have been summarized and discussed in this paper. Below, we present the methods adopted, and in the results (see *Results*), we provide a summary of the strategies (see *Summary of strategies*). In *Research projects presentation* and *Workshop activities*, we contextualize the strategies by relating them to examples from our research projects and from workshop participants' experiences.

Reflexivity on research projects

The elements of strong sustainability discourses (i.e., *Strong sustainability characterisation: engagement with the capitalist growth-driven system*) guided the reflexivity exercised in this study. Reflexivity plays an important role in transdisciplinary practices (von Seggern et al., 2023). Reflexivity is defined as the capacity of actors (e.g., researchers) to reflect—to be reflexive—and explicitly consider and acknowledge the assumptions and values that influence their own thinking and, therefore, affect research projects (von Seggern et al., 2023). Reflexivity approaches have been adopted to respond to the main question of this study, which seeks to explore ways of fostering and working with (strong) sustainability transition framings while operating in transdisciplinary settings. This approach invites researchers to reflect critically on methodological choices, aims, and projects' intentions and effects (West & Schill, 2022). Reflexivity approaches provide a space to reflect on various social phenomena that can influence sustainability research projects (von Seggern et al., 2023).

We used a reflexive practice to consider three research projects (cases or case studies) in which we have been involved as researchers, with the aim of distilling relevant research strategies that may support the exploration of strong sustainability with diverse actors. The exploration of the cases enables a reflection (i.e., identifying particularities and complexities) on a phenomenon within a particular context. This approach is particularly useful in analyzing a complex phenomenon within a real-life context (VanWynsberghe & Khan, 2007). Reflecting on case studies represents a way to explore new insights into what has been or should be done, new perspectives, and interpretations of events (VanWynsberghe & Khan, 2007).

In this study, we employed a reflexive approach to analyze our experiences with three distinct projects in which we have previously conducted research. Specifically, attention was given to research goals, outcomes, and strategies adopted (i.e., *Research project presentation*). The first research project was specifically designed to investigate strong sustainability perspectives by focusing on postgrowth food system transitions. The second and third cases were transdisciplinary projects conducted in collaboration with non-research partners from government departments responsible for managing systems facing transformational changes due to climate change and other drivers of global change. Research project 2 focused on the management of an internationally protected wetland, while project 3 addressed disaster risk reduction in preparation for changing natural hazard regimes. While cases 2 and 3 did not explicitly use a strong sustainability framing, they were successful in working with partners to open deeper questions relating to the societal system within which they are operating, which is a core foundation of strong sustainability approaches. The interest in these additional cases (2 and 3) was to identify strategies that enabled these projects to engage with systemic causes of transformational change and reflexively assess the degree of incorporation of strong sustainability. The authors selected these cases because they correspond to the most recent transdisciplinary projects they worked on. All three cases were transdisciplinary because they (1) took real-world problems as starting points, (2) acknowledged context-dependencies related to these problems, and (3) co-produced knowledge and change with non-research partners (Barth et al., 2023; Chambers et al., 2022; Riedy et al., 2025).

Workshop

In addition to the research project reflections, we explored these questions with external peers by organizing a 1.5-h workshop at the Transformations Conference

2023 in Sydney. The conference theme was "Transformative Partnerships for a Better World." This paper has been submitted as part of the special issue linked to the conference, and participants in the workshop were not selected. All conference participants had the opportunity to join the workshop. The workshop, titled "Navigating the limits to plurality in sustainability transformations," involved three interlinked activities: (1) exploring conceptualizations of "weak" and "strong" sustainability; (2) using a system thinking "iceberg" model to reveal root systemic causes of a problem; and (3) hearing people's experiences in exploring deeper, systemic change with research partners and stakeholders. The outputs of these activities are presented in *Results*. Activities 1 and 2 helped frame Activity 3. Specifically, Activity 1 invited participants to write down the words and concepts that they associated with weak and strong sustainability. This exercise was designed as an individual activity that prompted participants to explore their understanding and concepts linked to these sustainability labels. We then collected all the participants' papers, clustered them into categories, and summarized them into a table, which we present in the results (see *Workshop activities*).

Activity 2 involved using a system thinking "iceberg" (Figure S1) (Abson et al., 2017; Maani & Cavana, 2007; Meadows, 1999) to identify the systemic causes of an issue or problem that participants cared about. Mental models, which can represent, for example, beliefs and assumptions, correspond to the deepest layers of systems thinking and influence systems structures (Maani & Cavana, 2007). Participants worked in pairs or small groups and were directed to "pick an issue or problem you care about, and fill out the systems thinking iceberg." Photos of the papers containing the icebergs were collected by the main researchers. However, these results are not presented in this article, as this activity was mainly organized to prepare participants for Activity 3, which is the main focus of this study.

Activity 3 invited participants to discuss in table groups their experiences in exploring questions of systemic change in the systems they work in. One of the barriers to engaging with strong sustainability perspectives is that it requires a willingness and capacity to critique the system within which actors are operating. Asking participants about their experience with engaging with deeper, systemic levels and options for change was a way of focusing on this core requirement while also ensuring we could hear from wider experiences that do not necessarily involve working with strong sustainability perspectives. The questions were: "What are your experiences in working with people to explore deeper, systemic levels?" and "What has helped or hindered you in getting to deeper levels with people?" Participants discussed these questions in small groups and then reported back in a plenary discussion. During the discussion, one of the authors of this paper was transcribing the discussion. These notes, in addition to the papers collected from participants, were then summarized and presented in the strategies (see *Results*). The intention was not to be comprehensive, nor seek agreement and consensus from all participants. Rather, the themes from the discussion were used to identify insightful points of relevance to this paper. The workshop activities were conducted under the approval of our organization's Social Science Human Research Ethics committee (ethics approval 083-23), in accordance with the National Statement on Ethical Conduct in Human Research (2007, updated in 2018) and our organization's Privacy Policy and the Privacy Act 1988.

RESULTS

Summary of strategies

The findings of the analysis of the cases (see *Research project presentation*) and workshop activity (see *Workshop activities*) highlighted 12 strategies that enabled researchers and practitioners to work in transdisciplinary partnerships for system exploration, including incorporating strong sustainability perspectives. These strategies are summarized in Table 1. Some strategies emerged from the analysis of the cases (i.e., Table 2) and some from the workshop activities (i.e., quotes in *Workshop activities*). The strategies are then contextualized in *Research project presentation*, with the introduction of the research cases, and in *Workshop activities*, with the presentation of the findings from the workshop activity. As discussed in the *Discussion* section, these strategies do not work in a linear sequence; they can be applied in concert to support each other.

Research project presentation

All three research projects aimed at co-producing knowledge for sustainability transitions. While the authors who worked on the cases presented belong to the same institution, this type of research is common across institutions. Table 2 presents an overview of the research projects and the strategies used to explore sustainability or systemic change. The objective of the first research case was to explore food systems transitions, and it specifically focused on enabling strong sustainability transitions. The other two research projects did not adopt an explicit strong sustainability framing; however, they sought to

TABLE 1 Strategies to foster strong sustainability research resulted from the research cases analysis and the workshop activity.

No.	Strategy	Description
1	Foster an authorizing environment within the research institution	Strong sustainability transdisciplinary research is influenced by the institutional contexts in which researchers work. Institutions' norms, values, structures, and culture can influence researchers' opportunities and limits. While these elements might be context-dependent, all institutions and researchers are influenced by them. Fostering enabling conditions for exploring strong sustainability can be challenging, and requires building capacity at institutional levels to foster reflexive governance. Research leadership and governance arrangements play a crucial role in establishing such authorizing conditions.
Strategy 1 present in: cases 1, 2, and 3		
2	Foster reflexivity and clear positionality	Researchers' values and positionalities shape the framing of research questions and methods, and rendering these influences explicit provides a greater level of transparency and accountability for researchers. Explicitly stating positionality can also help build trust in new partnerships and working teams.
Strategy 2 present in case 2		
3	Work in interdisciplinary teams that include diverse specialist expertise related to systems and strong sustainability perspectives	Interdisciplinary teams ensure the inclusion of different knowledge and perspectives. Strong sustainability perspective can be represented by ensuring the team includes specialist experience in fields such as: working with multiple values associated with nature (intrinsic, instrumental, and relational values); using system methods to identify root/structural causes of problems and reveal unintended system outcomes, and using methods that recognize and address power dynamics.
Strategy 3 is present in cases 1, 2, and 3		
4	Foster broader context awareness	Broad contextual factors shape what research activities can and cannot occur, and so increased contextual awareness allows for greater responsiveness to windows of opportunity when they occur, and appropriate entry points for introducing new concepts and approaches.
Strategy 4 present in case 3 and workshop		
5	Design of the research questions and boundaries	Important elements of strong sustainability perspectives include the recognition of multiple values (beyond instrumental values), a focus on system change, and the recognition of power and justice as legitimate objects of inquiry, so the research questions and boundaries need to be defined in ways that accommodate these elements.
Strategy 5 present in cases 1, 2, and 3		
6	Establish clear criteria for who to involve	Decisions about who to involve in a research inquiry, and how, is a crucial determinant of whether strong sustainability perspectives are represented or not. Clear selection criteria can provide transparency on whose interests and values are included in the research inquiry and why. It allows clear articulation of assumptions about who has agency in the system of interest and prompts reflection on the representation of marginalized actors and incumbents.
Strategy 6 present in cases 1 and 2		
7	Develop a theory of change	A theory of change is a clear explanation of how and why a project or program of work will achieve its goals. It outlines the key steps and actions needed, as well as the assumptions behind them, to understand how each part leads to the desired outcomes. It creates

(Continues)

TABLE 1 (Continued)

No.	Strategy	Description
		opportunities to explicitly consider the long-term outcomes, and how a single project could contribute to a longer-term program of system change.
Strategy 7 present in case 2 and workshop		
8	Adopt strength-based approaches	Framing collaborations to focus on the desired change, assets, and strengths available among partners to contribute to such change. This approach can foster greater collaboration and willingness to change than a focus on identifying problems. It also ensures the work goes beyond diagnosing problems to recognizing existing assets and strengths that can be put to use toward their resolution.
Strategy 8 present in cases 2, 3, and workshop		
9	Foster trust with partners and actors	Trust among partners and other actors in the system is a core requirement for any open exploration of new, perhaps confronting perspectives, and for engaging with future change. Without trusted relationships, it will be difficult to engage with concepts and approaches that challenge the status quo.
Strategy 9 present in cases 2, 3, and workshop		
10	Establish trusted knowledge sources	Trusted bodies of knowledge or expertise provide valuable common ground for research projects and participants, upon which differences in interpretation or implications for actions can be explored and clarified. Collectively establishing which knowledge sources are legitimate and why supports the generation of findings grounded in trusted knowledge.
Strategy 10 present in cases 1, 2, and 3		
11	Enable authorizing conditions for partners and participants	Transdisciplinary co-production activities can only explore deeper systemic causes of observed phenomena, and alternative system configurations, if participants are willing, able, and free to do so. Researchers can help create those enabling conditions or engage with recognized authority figures that can endorse an authorizing environment in which is it made explicit that participants can step outside the usual confines of their role, and comment on things that are beyond their immediate responsibility or sphere of influence.
Strategy 11 present in cases 2 and 3		
12	Welcome and socialize new narratives.	Creating new systems that do not yet exist in the world typically entails new language, whether it be concepts that have not yet been named, or narratives that reflect an alternative perspective. New terms and narratives can provide a valuable scaffolding for helping people explore and build different understandings of system change or to resist the status quo.
Strategy 12 present in cases 1, 2, and 3		

enable transformational system change, which is a foundational requirement for any strong sustainability framing. These projects engaged with deep, systemic, societal drivers of change, focusing on transformational change; however, their focus was domain-specific (primarily climate change). These examples show the complexity of sustainability research.

Additionally, a main difference between the first research project and the other two is that in the first case, researchers had the opportunity to design the research project and select the participants for the study (the project was internally funded), while in the second and third projects, researchers were approached by non-research actors (clients, externally funded projects) to work collaboratively on a specific challenge. This main difference influences the strategies adopted, which indicate that how projects are set up (e.g., their funding, researchers' autonomy) influences the process. Yet, increasingly, in research institutions, both realities exist, hence, it is important to consider different cases.

TABLE 2 Research case summary.

	Research project 1	Research project 2	Research project 3
Main goal	To explore food systems transitions in Australia and design a project exploring how to navigate these transitions with stakeholders.	To explore adaptation options for an internationally protected Australian wetland ecosystem facing transformational change due to climate change.	The research aimed to reframe national narratives around disaster preparedness to reduce harm and suffering in a more systematic way.
Why was it selected as a case to consider in this paper?	The project worked with a strong sustainability framing with non-research partners.	The work explored systemic vulnerabilities to climate change, which included systemic vulnerabilities arising from institutional and governance arrangements, so requiring a willingness and capacity to critically analyze the system within which participants operated. The project navigated institutional tensions between engaging with resisting marginal near-term change to the wetland and adapting to longer-term transformational change.	The work explored systemic vulnerabilities to natural hazards, including vulnerabilities arising from interacting social, economic, and ecological systems, requiring a willingness and capacity to critically analyze the systems within which participants operated. The approach engaged with the tension between systematically reducing exposure and sensitivity to events, and traditional approaches focusing on preparedness and response.
Key outcomes	The work is ongoing, but early outcomes include new insights into systemic barriers faced by postgrowth food enterprises and potential enablers for strong sustainability transitions.	Independent review of the project found the work fostered new knowledge and capacities with government research partners by exploring issues in ways novel to them and equipping decision-makers with helpful ways to think about and address transformational change.	The work underpinned new guidance, co-developed with government partners, for undertaking vulnerability analyses for revealing and addressing systemic risk reduction. It led to a series of follow-on projects developing implementation pathways.
Strategies that enabled exploration of (strong) sustainability perspectives or critical systems analysis	• The program was designed to foster interdisciplinarity. Team discussions prompted an investigation and clarification of sustainability discourses (Strategy 3). • Previous research findings have been used to frame the project (e.g., planetaries boundaries) (Strategy 10). • The exploration of different sustainability discourses led to a reflection on positionalities (Strategy 2), which then shaped the design of the research project (Strategy 5). • The characteristics of strong sustainability were used as criteria to target "change-ready" actors in agri-food systems (i.e., postgrowth food enterprises) (Strategy 6). • Research activities socialized narratives such as degrowth and postgrowth (Strategy 12)	• Senior government leadership and project governance arrangements created an authorizing environment for government officers to take a system view beyond their usual areas of responsibility (Strategies 1 and 11). • The project leader deliberately fostered reflexivity at personal through to institutional levels, clarifying the values and positionalities motivating the work (Strategy 2). • Project activities involved bringing together interdisciplinary expertise to provide diverse perspectives on the system (Strategy 3). • Co-development of a system map identified past and current institutions, actors, decisions, and events that have shaped current decision-making	• Senior government leadership and project governance arrangements created an authorizing environment for research institutions and government agency partners to take a system view beyond their usual areas of responsibility (Strategies 1 and 11). • Interdisciplinary teams from different agencies all contributed insights to the work, coordinated by specialist expertise in systems analyses (Strategy 3). • An external advisory team fostered broad context awareness and guidance for introducing new concepts with diverse actors (Strategy 4). • The research questions placed a focus on systemic risk and system change, and institutional arrangements and system/structural causes were

(Continues)

TABLE 2 (Continued)

	Research project 1	Research project 2	Research project 3
	and to do so researchers collaborated to create the conditions for exploring these narratives within the organization (Strategy 1).	arrangements and future outcomes (Strategy 4). • The project was designed with research questions and methods aimed explicitly at enabling transformational system change in the service of multiple values (Strategy 5). • Clear criteria for who to involve (specialist disciplinary expertise and government officers) allowed a focus on interactions between the biophysical system and institutional arrangements (Strategy 6). • The co-development of a theory of change supported reflections with partners on how the project could contribute to long-term change beyond the project (Strategy 7). • The research methods characterized current institutional arrangements and strengths that could be built upon to address challenges (Strategy 8). • The research team was highly attentive to partner requirements, revising the plan to allow additional time for negotiations that strengthened trust between researchers and partners (Strategy 9). • Previous research provided biophysical knowledge about climate change impacts that research partners and participants trusted. This was vital for eliciting more qualitative, descriptive information about people's values and institutional arrangements (Strategy 10). • Participatory activities socialized unfamiliar concepts such as climate-readiness and transformational adaptation (Strategy 12).	an explicit object of inquiry (Strategy 5). • The methods focused on co-developing knowledge and practices for successfully living with extreme events, building on existing capabilities (Strategy 8). • The project allocated time and resources for developing partnerships and co-developing joint activities that built trust between partners (Strategy 9). • Cross-agency development of credible future scenarios supported by research findings provided a trusted knowledge foundation (Strategy 10). • The project was designed to develop and communicate new narratives about societal vulnerabilities to natural hazards, fostering understanding of ways in which vulnerabilities to natural hazards arise from societal values and systems (Strategy 12). • Inclusive, plain language was used to characterize diverse perspectives, acknowledging attributes of different worldviews without political labels or judgment (Strategy 9).
Reference	N/A (the project has not finished yet)	O'Connell et al. (2018)	Dunlop et al. (2022)

Workshop activities

The workshop attracted 17 participants, all with experience to contribute to the workshop theme of navigating plurality in sustainability transformations. Data on participant demographics and backgrounds were not collected. The participants were not assumed to be a representative sample of sustainability scholars and

TABLE 3 Categories that emerged from weak and strong sustainability activity.

Weak sustainability	Strong sustainability
Little or no acknowledgment of limits	Acknowledges limits and sets boundaries/caps
Perverse/unintended system consequences are out of scope	Seeks equitable benefit sharing
Focus on corporate reporting	Emphasizes diversity, inclusion, and collective learning
Short-term, narrow focus, short-term and reactive	Anticipatory, long-term, closed-loop, or regenerative approaches
Focus on technological fixes	Engages with complexity and contested perspectives
Focus on individual/private responsibility	Focus on structural rather than individual change
Focus on market-based values	Acknowledges multiple values and non-substitutability of incommensurable values
Risk of greenwashing/box-ticking	Focus on root causes and system change

practitioners. Rather, the workshop was an opportunity to hear conceptualizations of strong and weak sustainability and experiences with system change (i.e., necessary for strong sustainability approaches) from participants.

In Activity 1, participants produced 41 concepts associated with weak sustainability and 51 with strong sustainability. These were clustered and summarized after the workshop (Table 3). The interest relied on exploring whether participants' perceptions of weak and strong sustainability aligned with the literature presented in *Strong sustainability characterisation: engagement with the capitalist growth-driven system*. Although the workshop exercise was short and not intended to be comprehensive, this portrayal of strong sustainability (Table 3) is consistent with the features found in the literature (see *Strong sustainability characterisation: engagement with the capitalist growth-driven system*).

The participants' characterization of strong sustainability recognized that a willingness and capacity to address root causes and system change is foundational. Moreover, by inviting participants to reflect on their perceptions of sustainability, Activity 1 helped prepare participants to transition to the second activity, which aimed at linking perceptions of weak and strong sustainability to the systems-thinking exercise. This first activity positioned participants well for Activity 2, where they were invited to populate a systems-thinking iceberg model in pairs or small groups. Each pair (or group of three) of participants selected a different topic from their own experience (e.g., Figure S2). Topics included climate injustice, access to safe drinking water in households in the Mekong Delta, the role of organizations in the climate crisis, plastic pollution in the ocean, intergenerational differences in knowledge acquisition and literacy, and the nature of knowledge for sustainability.

Activity 3 involved a plenary discussion to report on the internal group discussions that were held during Activity 2. Several participants mentioned challenges in setting boundaries and being able to explore the deeper levels with the stakeholders they had engaged with in previous work. For example, a participant, referring to their experience in working with some stakeholders on a project, mentioned that: "the partner wanted to see it as a biophysical problem, [...] didn't want to frame it as an institutional problem. We felt we had insights they didn't have. We had an ethical dilemma of imposing that on them. How to take them to a deeper level in a legitimate way. [We had] a real difficulty in getting from the operational—biophysical level for the partner, to see that the problem they are trying to solve has more systemic issues that need to be addressed." Additionally, "going to different levels required a re-framing of a problem, which is seen as a threat to the ego, or institutionally or professionally. It's a barrier. This is hindered by 'projectification' of engagements. Building more of a relational approach where people trust each other [can help] get past perceived threats of viewing the problem in a different way" (Strategy 9, Table 1). This last participant highlighted how "projectification" (i.e., the tendency to work on short-term projects) poses challenges (e.g., time constraints) in building trusting relationships that enable the exploration and reframing of a problem.

Another person in the room followed up by saying, "speaking just for me – that piece of the emotional psychological safety is so critical. ... If you are trying to get to this root cause, [it is important to] be sensing where the person is at, are they feeling safe, pissed off or uncomfortable? Be attentive to the facilitation of that. How to get to the deeper bit?"

Participants spent some time discussing the importance of creating a "psychologically" safe environment for stakeholders to tackle sustainability challenges. Participants also pointed out that issues often arise in the research design pointing to a need for greater reflexivity in the design process (e.g., "In our table, we spoke about who is in the room and how to get those people in the room. When people have fundamentally different worldviews it is hard to bring them together" and "within transition studies there are differences in how you describe transitions (technocratic perspective or not); there is a huge split, worldview wise in academia, because we are

not discussing what sustainability actually means, and how we are recreating technocratic views").

Another person suggested that orienting the research approach toward finding solutions (Strategy 8, Table 1), rather than discussing the problems, might be a way to overcome engagement challenges (e.g., "If you start with the problem ... I don't want to go to meeting when I'm the problem. [...] Framing something as to what is the goal/vision/intent might be useful to surface world views. Getting to a place where people recognise they do have those differences, and what does that mean for a shared vision. [...] Take away from problem focus").

A participant acknowledged that the conference workshop was a safe environment for them to discuss challenging topics (e.g., "the issues of living in an extractive society"), adding that, in general, it is "harder to have constructive conversations in the lower ends of the pyramid [i.e., iceberg model from Activity 2]." Later in the workshop, another participant echoed this concern, expressing that to start (systemic and challenging) conversations, "you need the skin of a rhino! But you can start them"—and suggesting that it is important to "get the bits in place so when you do get the opportunity you can make the most of it because windows are short-lived," therefore it is important to "know in depth your environment" (Strategy 4, Table 1). The group discussed the importance of opening some conversations at appropriate times, utilizing "windows of opportunity" even if, as a person in the room highlighted, "those windows are hard to work with, I have received phone calls from power holders who needed an answer in a short space of time." Another participant added that, sometimes, "breakdowns, shocks (cyclones, COVID-19) in the system give you alternative narratives." Going into more detail, another person added: "got to invest so much time into knowing landscape in depth so when the opportunity comes up, you are ready to pounce, share alternatives. The global financial crisis is an example – had there been alternatives to bailing out banks, wouldn't that have been great? Covid was amazing – who would have thought we'd be having conversations about supply chains every day! Pretty amazing. Crises can trigger quite considerable paradigm shifts."

Time scales in transdisciplinary engagement surfaced in different ways. On one hand, participants said that the short duration of projects often does not allow for exploration of deeper levels (e.g., "I have to start that process all over again with new people institutions and help them make manageable systemic change – the biggest challenge. There is a tendency to be issues-based and project-based"). On the other hand, having a long-term theory of change (Strategy 7, Table 1) was suggested as a useful strategy, recognizing there is "quite a lot of talk about starting the conversation, but true systemic change is harder to achieve, and it is an intergenerational work. Slow, historically." Another person added that "when you start and where you end up in 5-10 years, [is it] hard to trace back to point of origin!"

While the workshop's sample size was just 17 participants, the outputs revealed valuable insights that enriched the reflections from our own research projects and gave rise to additional strategies adopted to navigate the tension explored in this study.

DISCUSSION

Advancing transdisciplinary approaches for strong sustainability

> The claim to be ethically neutral and ideology free is itself an ideological claim. (Harvey, 1974, p. 256)

In transdisciplinary research, it is important to engage with diverse societal actors who may hold, for example, different views of sustainability. Despite the growing interest in recognizing plurality in transdisciplinary sustainability research (Chambers et al., 2022), shades of weak sustainability, such as those at the palliative (e.g., technological solutions) and hopeful (e.g., market-based solutions) end of the spectrum, continue to be more explored than others (Biely & Chakori, 2025; Morrison et al., 2022; Ruggerio, 2021). These weak sustainability perspectives and approaches remain more explored for several reasons. For example, one reason relates to the fact that weak sustainability tends toward reproducing and sustaining the dominant growth-driven economic system, rather than exploring societal transformation by questioning notions of development and economic growth (Ruggerio, 2021). Another reason includes the fact that weak sustainability relies on symptomatic solutions that require less effort to implement and so can be more appealing when compared with more difficult, long-term, systemic efforts (Bayer, 2004; Kim & Anderson, 1998; Senge, 1990). Moreover, the focus remains on weak sustainability because some stakeholders rely on various methods (e.g., instrumental, discursive, material, and institutional forms of power and resistance) to resist changes that threaten their interests (Geels, 2014). As pointed out also in the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (Denton et al., 2022), some groups have vested interests in locking in the status quo and utilize, for example, concerns over job losses and

dislocation to prevent transitions. For example, some resource-intensive and fossil-fuel industries have been reported to leverage their resources and positions to undermine systemic transitions (Geels, 2014; Denton et al., 2022; Stoddard et al., 2021). Moreover, greenwashing is an increasing phenomenon in modern societies (de Freitas Netto et al., 2020). Greenwashing is a disinformation approach adopted by firms to mislead consumers regarding their business environmental practices and performances: to sell "green" products, firms adopt positive communication (marketing strategies) about environmental sustainability, despite perpetuating a poor environmental performance (de Freitas Netto et al., 2020). There is a growing demand for sustainable products (e.g., from consumers), however, instead of pivoting business models to align with sustainable practices, some firms continue to prioritize business-as-usual while marketing their products as green (de Freitas Netto et al., 2020). Thus, weak sustainability approaches can potentially undermine stronger sustainability goals rather than contribute to them (Table S1, provides some additional examples). Therefore, the increased risk of embracing transdisciplinary approaches without the inclusion of strong sustainability perspectives is that the "anything works for sustainability" view (Partidario et al., 2010) could undermine systemic efforts because the simpler, but not necessarily effective, solutions are preferentially engaged with. In the next paragraphs, we discuss the key strategies revealed in the cases analyzed and the workshop session that focuses on building the necessary enabling conditions for transdisciplinary partnerships to be able to engage with strong sustainability. While several strategies have been implemented across the cases and by workshop participants, in this discussion, we delve into some of them, expanding on the cases analyzed because the authors are more familiar with these projects. Nevertheless, as presented in the results, several strategies have been used across cases and by workshop participants.

As illustrated below in Figure 1, a combination of several different strategies may be required to expand the sustainability discourse. Depending on the context, researchers might adopt a single strategy or a combination of them. Different combinations and sequences can exist, there is no linear process. For example, Strategies 1–4 are about establishing an enabling research institutional context and values. With these enabling conditions in place, researchers are in a better position to design a project or program of transdisciplinary research that directly addresses the risks of privileging weak over strong sustainability (Strategies 5–8). Moon and Blackman (2014) encourage researchers to understand and recognize the principles and assumptions that are

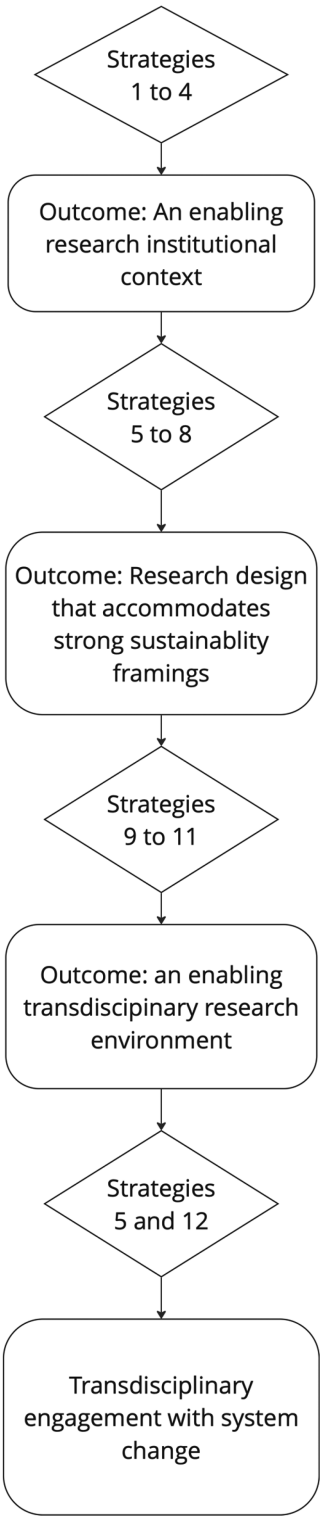

FIGURE 1 Examples of combinations of strategies used to frame strong sustainability research.

embedded in their studies. By explicitly recognizing the positionalities that underpin sustainability research, reflexivity offers avenues to guarantee a level of self-reflection within co-production processes. Though reflexivity is becoming more recognized in transdisciplinary

studies, it is not yet routinely operationalized and integrated systematically into research processes (Mochizuki & Wada, 2022; West & Schill, 2022).

Many research projects do not explicitly explore or state, for example, their positionalities, ontology, and epistemology. Understanding and stating positionalities helps clarify, for example, the choice of research questions and boundaries, and the selection of subjects and stakeholders. Stating the boundaries adopted in research is not just a philosophical exercise; ultimately, the positionality and interests of research teams and/or their organizations influence the stakeholders' engagement process and overall research project. Reflexivity also invites researchers to critically acknowledge these aspects at an institutional level, where the preconditions of researchers' daily work are set, because institutions' interests and power (e.g., "including but not limited to who owns the research outlets"; Kish et al., 2021) are part of the dynamics of the system that are explored and that researchers seek to change. Depending on the politics of the research agenda, resources (e.g., time, funds, human knowledge) are used to privilege some perspectives over others, and some engagements over others. Discussing the ethical–political dimensions of research methods West and Schill (2022) emphasized that the recognition of positionalities, through reflexivity, also helps with accountability. Therefore, referring to reflexivity practices, von Seggern et al. (2023, p. 2) wrote that "these procedures enable reflexivity to function as a kind of protection: collective reflexive practices protect researchers both from being instrumentalized by political and economic actors and from being unknowingly subjected to the dynamics, norms, and habits that result from the inner logic of the scientific field itself."

Approaching research projects with interdisciplinary teams (Strategy 3) can help to explore different positionalities and enrich the outcomes. The multi-facets of sustainability transitions (e.g., social, ecological, and embodied debt) are better explored by interdisciplinary research teams (Sovacool, 2021) because different academic backgrounds enhance the exploration of sustainability transitions and the nexus between all the components for strong sustainability. For example, in research project 1, reflexivity was also prompted by the interdisciplinary nature of the team, which tackled different concepts and understandings of sustainability. The process of explicitly unpacking and explaining sustainability understandings and aims led to deeper reflections on concepts and influenced the research redesign. In case one, researchers decided to (re)design the project (Strategy 5) to include strong sustainability lenses and more marginalized actors. This change took additional time and energy from all team members—the price for higher sustainability ambitions. As presented in *Strong sustainability characterisation: engagement with the capitalist growth-driven system*, transitions based on strong sustainability are framed such that the political and economic system is in scope for analysis and change. Tasked with exploring food systems transitions, the team of the first research project decided to select and work with postgrowth-oriented food enterprises (i.e., "change-ready people") who work explicitly toward systemic change, challenging the growth-driven system. Moreover, in this research project, the decision was also influenced by the willingness to close a research gap. In the OECD region, Australia ranks the lowest in terms of research institutions' relationships with small and medium enterprises (Verreynne et al., 2021). Most research projects continue to engage mainly with large enterprises (Verreynne et al., 2021). Therefore, choosing whom to engage with in transdisciplinary research studies warrants careful planning and justification. Strategies 8–11 are about establishing trusted relationships and knowledge sources, and enabling safe, authorizing environments for partners and other actors. Asset-based approaches (Strategy 8), as suggested by the participants of the workshop, can help create safe and exploratory environments. Asset-based approaches can be adopted to foster transformations by establishing a working environment in which conversations begin by focusing on and strengthening the abundance of existing assets defined as, for example, individuals, their skills, and relations, rather than engaging with (problematic) scarcity (e.g., of solutions) and deficit. Together, all these strategies create the foundations for transdisciplinary partnerships that can work with strong sustainability concepts and approaches.

Another way to elevate the exploration of strong sustainability is by introducing and socializing new narratives (Strategy 12). These could be stories that define a problem, and pose objectives and related actions and solutions (Luederitz et al., 2017). Comparing different narratives (e.g., weak and strong sustainability) can foster awareness of alternative sustainability transition solutions. Narratives convey system framings, which, as explained in *Summary of strategies*, reflect how actors articulate system boundaries and desired goals (Luederitz et al., 2017). As a consequence, narratives function as a justification for particular interventions, influencing transition pathways (Luederitz et al., 2017). In the first research project, the team chose to collaborate with degrowth-oriented food enterprises to explore pathways for strong sustainability. This approach was informed by degrowth and postgrowth literature (Strategies 10 and 12) and included the task of introducing these relatively new narratives in Australia. Socializing such narratives can be a challenging task because they require challenging

mental models at the basis of the systems-thinking iceberg. Introducing new research questions, findings, literature, or narratives can lead to resistance from various actors, both internal and external to research institutions (e.g., research colleagues, policymakers, sponsors), which can influence projects. Who we are and where we are located largely determine what questions are explored and what outcomes are tolerated (Salleh, 2009). The foregrounding of postgrowth concepts in case study one is an outlier in the wider research program and has been described as "provocative" by some in the program. While this word often comes with a negative connotation, the origin of the word, which over time assumed different connotations, comes from Latin, *provocativus*, and could be simply translated into "calling forth" (*pro*—"forth/forward" and *vocare* "to call"), meaning challenging and stimulating. Some research inquiries, such as those that challenge the growth-driven system, remain perceived as more provocative than others. But, does "provocation," such as the one stimulated by alternative inquiry and research agendas, come into existence just when it is aimed at, or perceived as, a destabilization of power, interest, and privileges? Research subjects and movements can be perceived as provocative when they directly relate to values, beliefs, and interests. However, actions (e.g., selection of research topics or stakeholders) can also be provocative by design. For example, as degrowth calls for disaccumulation, decommodification, and decolonization (Hickel, 2021), it could be perceived as a provocative research agenda, or it can be purposely used as a provocative concept. But, as Hickel (2021, p. 1107) argued, "(...) intellectual transformation is enabled, not inhibited, by using a provocative term [i.e. degrowth]. Trying to avoid provocation, or trying to be agnostic about growth, creates a milieu where problematic assumptions remain unidentified and unexamined in favour of polite conversation and agreement. This is not an effective way to advance knowledge, especially when the stakes are so high." Therefore, although being "provocative" may be perceived as problematic, it has the potential to advance strong sustainability by bringing attention to power and politics. Attention to values and politics is crucial given the transformative potential of sustainability research, and the tensions that arise, for example, with power (Rosendahl et al., 2015). Here, politics is intended as the explicit and implicit choices (e.g., values, ethics) that frame and shape the research process and outcomes (Preston et al., 2015; van der Hel, 2018). Although transdisciplinary research has been proposed as a way to produce transformative knowledge able to question existing power structures and challenge the status quo, political and power dimensions are often not explicitly, or remain insufficiently, considered (Chambers et al., 2022).

As summarized in Table S1, the "weak" end of the sustainability spectrum does not engage with (or actively avoids) political analysis of the socio-economic system. Aspiring to be apolitical can be perceived as being more inclusive and supporting plurality because it is not forcing an overtly political, strong sustainability, agenda on others who may not subscribe to that view. However, another view is that being apolitical (e.g., by adopting weak sustainability approaches) is, in fact, simply accepting the dominant socio-economic and political reality, and doing so actually suppresses "genuine" plurality in which a greater diversity of knowledge, perspectives, and initiatives would be within scope for inquiry and action. Being "apolitical" in ways that align with the status quo *is* political. We argue that "genuine" plurality is not about striving to be apolitical or "agnostic" in ways that ignore politics or societal norms, but rather ensuring that these dimensions are not excluded, and it is safe to explore, critique and seek to change them. Reflecting on these aspects is crucial because efforts directed toward symptomatic solutions can divert energy and resources away from systemic solutions (Bayer, 2004; Kim & Anderson, 1998; Senge, 1990). Ensuring that transdisciplinary sustainability initiatives are genuinely open to working with strong sustainability framings is necessary if the risks presented above (and in Table S1, Supplementary Material) are to be recognized and addressed. Approaches at the "weak" end of the spectrum of sustainability risk undermining strong sustainability outcomes rather than contributing to them. A primary distinction is that many dimensions considered in strong sustainability approaches are simply missing or out of scope in weak sustainability initiatives. Rendering these dimensions irrelevant or out of scope is a value judgment (Table S1), and risks any interests associated with these dimensions being adversely impacted if they are not visible in decision-making processes. Acting as though these factors do not matter also risks reinforcing the status quo and hindering transformational change.

The second and third cases were not explicitly framed as advancing strong sustainability. Nevertheless, these projects offered insights into strategies for working with partners to engage with deeper, systemic analyses. Some situations are challenging and can hinder the ability to scrutinize the socioeconomic system, the social position of researchers, or the influence of politically dominant groups on scientific agendas (Rosendahl et al., 2015). For example, the second research project focused on a specific ecosystem, and the government agency research partners and participants had limited authority to act

upon influencing factors outside their direct areas of responsibility. Researchers in such transdisciplinary partnerships need to respect the constraints of their partners (e.g., if researchers are conducting research with a specific client, organization, or supported by a specific grant), and yet there is a risk of being limited to symptomatic solutions if participants are prevented from investigating and acting upon more systemic causes. However, we stress that, even in these more constrained conditions, researchers can seek to elevate research explorations to encompass the socio-political-economic aspects that enable participants to reflect on the broader systemic barriers and catalyzers of more transformative outcomes (Strategy 11). Researchers can play an important role as custodians of long-term (strong) sustainability thinking, and they can help people and their organizations expand their conceptualizations of sustainability transitions. As mentioned in the second and third cases, researchers and partners took on the role of facilitating an authorizing environment (Strategy 11) that enabled participants to explore deeper systemic causes. However, to be able to create an authorizing environment for research partners, researchers often need to influence their own institutional contexts (Strategy 1). Dryzek and Pickering (2018) refer to "reflexive governance" as the "capacity to question the foundations of political institutions." Strategies 1 and 11 contribute to building that capacity at institutional levels so that reflexivity is more deeply embedded in institutional structures and ways of operating. Dryzek and Pickering (2018) describe the importance of recognizing and anticipating social–ecological system phenomena, reflecting upon and rethinking core values and practices, and responding with new discourses and reconfigured functions and practices. These practices can enable deep systemic foundations to be questioned while being grounded in and responsive to ecological reality.

Finally, in the three transdisciplinary research projects explored, researchers have based the boundaries of the research on previous scientific evidence and frameworks (e.g., the planetary boundaries framework, peer-reviewed and well-accepted modeling of climate change impacts, and credible scenarios grounded in trusted evidence) (Strategy 10). However, although the idea of scientific neutrality and objectivity continues to persist in society, it is important to recognize that science represents rather than mirrors reality (Jasanoff, 2010; Rosendahl et al., 2015). Contrary to assertions that science is objective, universal, value-free, and context-independent (van der Hel, 2018), scientific research, in particular sustainability research, has always been grounded in distinctive cultural frameworks (Jasanoff, 2010). For example, western science and politics have both contributed to producing dominant understandings of nature (Jasanoff, 2010). Therefore, in transdisciplinary research, it is important to recognize the social position and power of all actors, including the researchers (Rosendahl et al., 2015; Scoones et al., 2018). It could be argued that, by explicitly assuming and stating positionalities, especially in contested environments, we could enhance "strong objectivity"—meaning, "adopting stronger standards for 'good' methods in order to maximize objectivity" (Rosendahl et al., 2015, p. 19). As Rosendahl et al. (2015, p. 24) expressed, "by adopting strong objectivity, researchers would not negate the existence of these [i.e. normative] assumptions, quite the contrast, they would reflect on how these influence and restrict the identification and conceptualisation of scientific problems and the formation of hypotheses." Therefore, assuming and stating positionalities can lead to opening the normative assumptions, which, by consequence, can support the exploration of the socio-political elements of (strong) sustainability. Researchers' position in the social matrix influences processes and conditions. Researchers have the power to be either gatekeepers or promoters of knowledge, values, and worldviews. Recognizing positionalities helps pay attention to forms of knowledge and actors representing them.

CONCLUSION

To face the socio-ecological challenges of the Capitalocene, urgent action is required. It may appear possible to effectively engage with both ends of the sustainability spectrum (weak and strong) in a compatible way; however, as we discussed in this paper, favoring weak sustainability can undermine (rather than contribute to) stronger sustainability goals. Weak and strong sustainability can represent antagonistic points of view (Ruggerio, 2021). This study stressed the need to pay attention to any barriers to the inclusion of strong sustainability perspectives and offered strategies to address some of the challenges. The study presented strategies, adopted in three different case studies and suggested by workshop participants, for creating the enabling conditions necessary for including strong sustainability perspectives, particularly those related to changing the system within which the research is being conducted. Combinations of these strategies can deepen the scope of sustainability research.

This paper's characterization of strong sustainability demonstrates that unless the political, social, and institutional properties of societal systems are regarded as legitimate objects of inquiry, critique, and change, strong sustainability approaches risk being framed out of scope. Even if, as workshop participants discussed, setting boundaries is a challenging task, we argue that it is

necessary to expand the boundaries of what is in scope so that sustainability research would also analyze the socio-economic-political dynamics.

More effective sustainability transition pathways could be explored by fostering enabling environments in which deeply embedded system goals, such as the pursuit of growth, can be considered. We argue that enabling strong sustainability perspectives to be included and regarded as credible, salient, and legitimate (Cash et al., 2002), rather than framed out of scope in a quest to be "apolitical" or "objective," is crucial because there is a rapidly narrowing window of opportunity to secure a livable and sustainable future for all (IPCC, 2023).

Strong sustainability pathways cannot be explored effectively without paying attention to the politics of knowledge. Researchers' and stakeholders' reflexivity (i.e., attention to values and politics) can help direct research inquiries so that it includes rather than excludes strong sustainability. Reflexivity can help address many challenges that arise within transdisciplinary research processes (von Seggern et al., 2023). Individual and institutional reflexivity practices can improve researchers' capacity to identify and balance different actors' interests in knowledge co-production processes. Including plural views and ambitions, that go beyond the status quo, is crucial because, as explained in this study, weak sustainability perspectives continue to be privileged, either because they require less effort to implement (Bayer, 2004; Kim & Anderson, 1998; Senge, 1990) or because some actors and organizations actively resist change (Geels, 2014; Denton et al., 2022; Stoddard et al., 2021). Therefore, individual and institutional reflexivity can be an important safeguard mechanism to determine which perspectives have been omitted, intentionally or unintentionally. Balancing strong sustainability ambitions with the engagement of diversity of actors and worldviews is, as West and Schill (2022, p. 9) argued, a deliberation exercise that fosters the ability to engage "in dialogue with 'those who think otherwise', in good faith and with an openness about one's own commitments and willingness to have them challenged — while also seeking points of connection and common ground where possible." Thus, we are not only invited to reflect on these aspects to improve methodological transdisciplinary approaches, but as researchers faced with negative socio-ecological well-being trends, we have the duty to protect plurality in sustainability science, and we can do so just by paying attention to the politics of knowledge.

Finally, we acknowledge the complexity of the current socio-economic crisis and the constraints that many well-intentioned sustainability researchers and practitioners face within this crisis, in their private lives and potentially in their working environment. We would like to thank all actors working toward strong sustainability goals. We recognize that often the work of co-producing and reframing narratives is invisible work. We recognize that the strategies proposed in this study, and the many valuable ones put forward in other studies, can be catalyzed only if there is a collective effort led by those who are more privileged (e.g., researchers who have greater agency and decisional power in their positions). Therefore, with this study, we hope that by calling attention to and normalizing reflections on the politics of knowledge, we could, on one hand, improve transdisciplinary approaches and, on the other hand, catalyze strong sustainability pathways to build a more socially just and ecologically sustainable society.

AUTHOR CONTRIBUTIONS

Sabrina Chakori: Conceptualization; data curation; formal analysis; investigation; methodology; project administration; validation; visualization; writing – original draft; writing – review and editing. **Nicola J. Grigg:** Data curation; formal analysis; funding acquisition; investigation; methodology; project administration; resources; supervision; writing – review and editing. **Katharina Biely:** Validation; writing – review and editing. **Katrina Szetey:** Writing – original draft; writing – review and editing. **Michael Dunlop:** Writing – review and editing. **Russell Gorddard:** Writing – review and editing. **Shane Hopkinson:** Writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

The research was conducted under CSIRO's Human Research Ethics Committee approval 083/23.

DATA AVAILABILITY STATEMENT

No data are available to share.

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SUPPORTING INFORMATION

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

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