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Ecological kin-making in the multispecies muddle: An analytical framework for understanding embodied environmental citizen science experiences

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Abstract

Despite the current proliferation of citizen science projects, the affordances of ecological citizen science to generate transformational thinking amongst project participants are seldom considered. This study investigated citizen science as an experiential ecopedagogic praxis that may provide a context for developing relational perspectives and sensorial engagements between human and non-human participants. A new humanist, phenomenological standpoint and narrative analysis framework were adopted. The narratives of five river monitoring citizen science participants are presented herein to illustrate an emergent Ecological kin-making through citizen science framework. Participants' narratives demonstrate how individuals engaged in caring practices through six embodied stages of ecological kin-making through citizen science: encountering the river (1); recognising the non-human world (2); river-bank identification (3); developing a sense of response-ability (4); enacting responsibility (5); and enhanced ecological kinship (6). As characterised by the infinity-loop framework, citizen science emerges from this study as an attuned, ongoing, and caring praxis of ecological kin-making. New co-species kinship relationships are formed, maintained, and strengthened through participation. The study highlights that where citizen science projects are designed with a participant community focus, they can create the conditions for self-directed and lifelong ecopedagogy that could be transformational for humans and non-humans in times of ecological and climate crisis. The study implies the catalytic validity of citizen science to provide a space-time context for participants to enact a 'response-ability' toward local environments and human and non-human dwellers, vital to enabling participants to experience a sense of agency and to take local action on environmental issues.

KEYWORDS

citizen science, ecological caring, ecopedagogy, embodied encounter, narrative analysis, new humanism

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1 | INTRODUCTION: CITIZEN SCIENCE, COMMUNITY, AND KINSHIP IN THE MULTISPECIES MUDDLE

The proliferation of citizen science projects signifies a participatory turn in environmental research (Dickinson et al., 2012). Research indicates that ecological citizen science participants can be motivated to contribute to scientific research (Geoghegan et al., 2016) due to environmental concerns (West et al., 2021) and acquire new knowledge through participating (Miller-Rushing et al., 2012), while involvement results in health and well-being benefits for participants (Dunkley, 2019). As a practice, studies have also indicated that citizen science enhances participants' aptitude to engage in environmental conservation (McKinley et al., 2017). This focus may arise through direct restorative actions related to citizen science projects (Dunkley, 2019) or via citizen science data outputs and their influence on environmental change governance (Cavalier et al., 2020).

Nevertheless, studies exploring the impacts of participating in citizen science are underdeveloped (Giardullo et al., 2022). Notably, the affordances of participation in ecological citizen science to generate transformational thinking amongst participants warrant further exploration (Stickney & Skilbeck, 2020). This study, therefore, investigated the potentiality of citizen science as an experiential, ecopedagogic practice (Dunkley, 2018a; Payne, 2018). The analysis focused on the affordances of citizen science within an ecopedagogic framework and as a prospective inter-relational praxis of environmental learning and action (Dunkley, 2017, 2022). Informed by Freire's (1970) critical pedagogy of consciousness-raising and inspired local action, ecopedagogy is conceptualised here as a Freirean-inspired ecological consciousness-raising praxis which inspires environmental action on the issues that are relevant to individuals and communities in particular times and spaces (Dunkley, 2018). This paper proposes that, in the twenty-first century, when awareness of climate change and ecological crises is widespread, opportunities for experiential ecopedagogic encounters are vital. This is because ecopedagogy enables individuals to explore local environmental issues and impacts while enhancing their sense of personal agency in the face of local and global ecological crises (Tengö et al., 2021).

1.1 | Citizen science: The emergence of engaged scholarship?

It is commonly stated that all ecological citizen science projects enhance relational understandings of the environment for participating individuals. Yet, projects vary greatly. Some citizen science initiatives involve relatively fleeting environmental encounters and engage participants as 'citizen sensors' (Catlin-Groves, 2012) or 'data drones' wherein scientists maintain leadership of traditional processes of scientific discovery (Ellis & Waterton, 2004). Such projects, regarded as 'instrumental' forms of citizen science, invite participation in discrete elements of scientific research. An example of this form of citizen science might be an annual garden bird count, whereby participants submit data via a website, post or email, with little or no interaction with those designing the citizen science project and wherein they gain little direct feedback on the study outcomes. At the other extreme, citizen science projects can be driven by citizens' shared motivations and interests, and relate directly to their everyday lived experiences and concerns. In such instances, citizen science is designed and conducted in collaboration with professional scientists (Ceccaroni et al., 2017). Thus, the extent to which citizen science projects can be considered ecopedagogic varies widely and is context specific. This warrants an approach that considers the variations in citizen science projects before embarking on a study that explores the effects of citizen science engagement for participants.

The citizen science project explored here ('Citizen Crane') is delivered by collective actors, including the Zoological Society of London (ZSL) and the local conservation group Friends of the River Crane Environment. The project is funded by a local utility company (Thames Water), which supports the project delivery with The Crane Valley Partnership and the Environment Agency. This spatially grounded project involved local communities in monitoring river health, using the Anglers' Riverfly Monitoring Initiative (RMI) methodology (<http://www.riverflies.org/rp-riverfly-monitoring-initiative>) to monitor freshwater invertebrates through kick-sampling. It required the engagement of small groups of local people living along the river tributary in regular monthly monitoring and data collection activities and reporting. The data collected through Citizen Crane are used as evidence to influence current and future environmental decision-making about river management, primarily facilitated through annual reports and forums (for more information, see <https://www.cranevalley.org.uk/citizen-crane/>).

'Citizen Crane' emerges from this qualitative study as an instance of citizen science. It enabled community members to participate in scientific data collection and enhance their ecological consciousness in a community setting. Engaging in data collection through citizen science emerges as potentially generative of enhanced human-nature relationalities

and inspiring local action (Stewart, 2018), as is central to effective ecopedagogy. The project raised local consciousness of environmental pollution. It enabled collaborative action facilitating regular reporting on the river's health and empowering participants to raise ecological consciousness amongst their wider communities. It is argued here that citizen science can enable a 'response-ability' (Haraway, 2016) amongst participants, enabling a response to environmental and social justice issues in a local space–time context (Dunkley, 2018a).

1.2 | Citizen science and transformative knowledge creation

For many scholars of citizen science, the approach offers a framework that can enable more inclusive scientific discovery processes fit for addressing the challenges of the twenty-first century. This is partly because employing citizen science approaches extends the scale and scope of participation in scientific knowledge-creation processes. With its roots in Enlightenment thinking, mainstream western scientific knowledge is predominantly framed by white, privileged male perspectives. Forms of knowledge considered 'other', including indigenous local knowledges, have until relatively recently been viewed as unrelatable to traditional scientific knowledge (Kimmerer, 2013). Concurrently, those engaged in scientific knowledge creation have perceived the disassociation of science from politics as key to ensuring the validity and objectivity of scientific research (Latour, 2014). Yet recent postcolonial scholarship in geography and social science has highlighted how knowledge production processes are imbued in power relations. For example, it is now well understood that geographical knowledge creation played a central role in injustices perpetuated in the name of empire building and colonisation (Tilley, 2011). Acknowledging these realities is crucial to creating a more equitable future of scientific discovery, not least within geographical research, which lives with its imperial legacies (Seitz, 2022).

Increasingly, the participation of diverse groups of people with equally diverse perspectives is upheld as the way to halt the abuses of scientific knowledge creation processes (von Hippel, 1991), while in a 'post-truth' era, some level of political engagement on the part of scientists, who may be engaged in scientific discovery that is in the public interest, is increasingly considered not only possible but necessary (Latour, 2018). Citizen science is acclaimed as a form of crowdsourcing data within a 'new age of modern science' (Esteves et al., 2017, p. 262), stimulated by increased global interconnectedness. It is a practice that, in theory, if not consistently, as noted above, challenges the traditional institutions of science (Irwin, 2002) by enhancing scientific participation while transforming mainstream science–policy–society interfaces (Vohland & Nadim, 2015). Citizen science arguably enables boundary-crossing between science and society (Ceccaroni et al., 2017), widening participation in science (Eitzel et al., 2017) and facilitating trusted environmental governance (Waterton et al., 2015). Nevertheless, it is crucial to note that there is a significant distance to travel before this society–science boundary crossing becomes widely accepted as a legitimate approach to scientific discovery within the scientific community (Haklay et al., 2014).

1.3 | The meaning of citizen science for participants: A self-directed ecopedagogic act?

To gain in-depth insights into participants' experiences of a complex, spatially situated and long-term citizen science participation, a new humanist (Simonsen, 2013) and new materialist (Arvidsen, 2018; Dolphijn & van der Tuin, 2012) phenomenologically (Merleau-Ponty, 1962) inspired standpoint is adopted. This study examined how ecological consciousness of multispecies 'interworlds' (Simonsen, 2013) could be cultivated through embedded site-specific and embodied praxis of environmental citizen science. This theoretical framing enables attending to emotional encounters between humans and non-humans (Bondi, 2005) through citizen science participation. Subjective narratives of situated citizen science are interpreted via a narrative analysis (Riessman, 1993) framework. Feminist (Butler, 2020; Haraway, 2016; Kimmerer, 2013) and relational lenses (Ingold, 2013; Kohn, 2013; Latour, 1993, 2017b, 2018) are applied to these narratives, enabling an exploration of the maturation of citizen science in a period of accelerated global environmental change (Mann, 2021) when social and ecological co-dependency has become adversely apparent (Latour, 2017b, 2018). Participants' narratives demonstrate how individuals work in situated contexts within citizen science projects to make ecological kin through embodied practices of care (Haraway, 2016).

This article demonstrates how citizen science participation can enhance openness amongst human and non-human co-species (Kohn, 2013; Simonsen, 2013). Citizen science enables multispecies encounters. These encounters are generative of a novel sense of care between humans and non-humans, allowing active co-species flourishing (Haraway, 2016). Caring for co-species is presented within this paper as an ecological kin-making through a citizen science framework

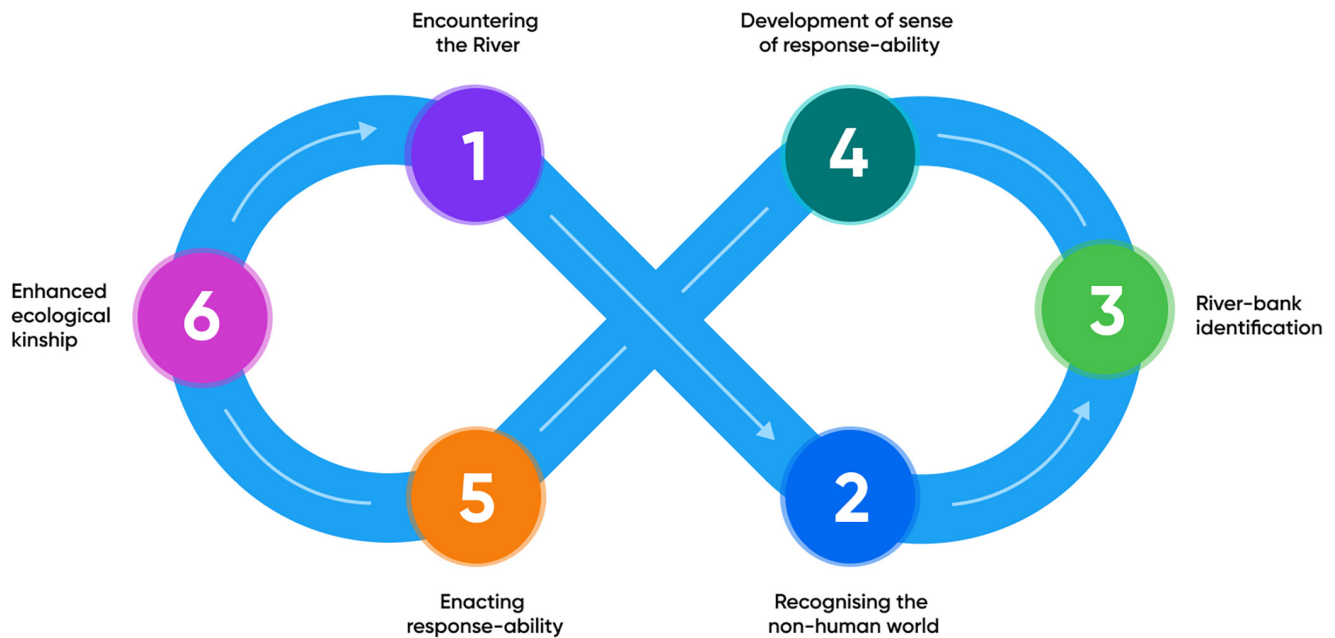


FIGURE 1 Ecological kin-making through citizen science.

(Figure 1). The ecological caring praxis of citizen science is likened here to Haraway's (2016) notion of 'composting'. Conceived as a progressive and ongoing praxis (Ingold, 2005), 'composting' is a praxis through which participants collaborate to enact 'response-ability' (Haraway, 2016) as part of a world-making praxis (Ingold, 2005), wherein co-species are 'at stake' to one another (Haraway, 2016).

The narratives of five citizen science participants are presented herein to illustrate the ecological kin-making through a citizen science framework. These narratives reveal the entanglements (Smith, 2016) created and sustained between humans and non-humans (Thrift, 1999) through a citizen science project on the River Crane, a tributary of the River Thames in London, UK. They provide qualitative insights into the embeddedness of individual bodies and consciousness within broader environments and social relations of power (Dolphijn & van der Tuin, 2012) in connected communities.

The ongoing process of ecological kin-making through citizen science, symbolised in Figure 1, is a movement through six interconnected phases. Initially, citizen science participants engage in embodied practices of wading, kicking, catching and feeling (stage one), allowing them to recognise that the river is alive with critters (stage two). Then they look at and record the species in their sampling trays (stage three). By analysing data collected on river-banks, participants recognise their 'response-ability' (Haraway, 2016) and that of the river critters (Kimmerer, 2013; Kohn, 2013). This response-ability is made possible by developing a 'relational sensibility' (Anderson, 2009, p. 125) generated through the invitation to participants to become familiar with river critters. This process leads to a growing awareness of humans and non-humans embroiled within co-dependent and co-constitutive webs, characteristic of living in a 'multispecies muddle' (Haraway, 2016) (stage four). Then, participants enact their 'response-ability' through river monitoring and evaluating the progression in the river's health over time (stage five). Journeying through these embodied stages is generative of a sense of ecological kinship between human and non-human participants, enhancing empathetic connections (stage six). Citizen science emerges as a praxis that enables transformational agency (Anderson, 2009; Kohn, 2013) within local environments on ecological concerns through ecological stewardship (Tengö et al., 2021). Acknowledging their transformational agency in the multispecies muddle becomes the basis for embracing nonviolent ethics of encountering the non-human world for citizen science participants (Butler, 2020). This non-violent relationship arises via a process by which participants reflexively 'make kin' (Haraway, 2016) with the river and non-human river corridor dwellers within complex ecological systems. The study implies the catalytic validity (Lather, 1986) of citizen science to provide a space-time context (Barad, 2007) for participants to enact a 'response-ability' (Haraway, 2016) toward local environments and human and non-human dwellers in times of ecological and climate crises.

1.4 | Ties that bind: Ecological kin-making in ‘Communities of Compost’

In the context of the Anthropocene, the need to acknowledge human–non-human entanglements is gaining ground on a broader social scale. Developing an ethics of non-violence (Butler, 2020, p. 16) has illuminated the interdependent existence of human and non-human beings who are ‘dependent, or formed and sustained in relations of depending upon and being depended upon’. This realisation requires humans to reevaluate how we live with ‘others’—humans, non-humans, environments and infrastructures, and to account for how ‘selves are implicated in each other’s lives, bound by a set of relations that can be as destructive as they can be sustaining’ (Butler, 2020, p. 9). Butler (2020) argues that by affirming these selves, it is possible to realise that environmental violence is an ‘attack on ‘bonds’ between relational ‘selves’ human and non-human. Therefore, sustaining an equitable liveable world is only possible ‘with others’.

The need to develop a theoretical framework that will enable a widescale reassessment of the nature–culture binary is also appreciated in anthropology (Ingold, 2011, 2013; Whitehead, 2009), wherein, for example, Kohn (2012) has proposed anthropology beyond the human. Bringing a new materialist framing to this discussion, Kohn (2013) suggests that relational anthropology, with its concern for semiotics, recognises that all beings, human and non-human, use signs to identify things, yet, different beings have distinctive forms of representation. As beings that grow and have subjective futures, non-human beings can also think about and represent humans in their own ways. Like Haraway (2016), Kohn (2013) determines that multiple realities, different from those humans project onto non-humans, are circulating simultaneously and that gaining access to these multiple realities involves looking for proliferating worldly patterns. Such new materialist anthropology does not see humans as separate from the world they represent. Kohn (2013, p. 215) suggests that humans can come to ‘think with’ forest thoughts if they can ‘become attuned’ to the forest. This attuning process, he argues, involves a ‘defamiliarising pedagogy’. This process of learning through becoming unfamiliar before reacquainting requires participants to take on the guise of the non-human, to inhabit the non-human perspective. Adorning this guise involves ‘donning what we might call clothing—the equipment, bodily accoutrements, and attributes that allow a particular kind of being to inhabit a particular kind of world’. A defamiliarising pedagogy enables participants to attend ethnographically to the non-human world. The process amplifies what is considered strange in everyday contexts rather than comparing or reducing it to pre-determined social categories.

Such conceptualisations of interrelational (Barad, 2007; Simonsen, 2013; Smith, 2016) and emotional spatiality (Bondi, 2005; Conradson, 2006; Jones, 2006) are not novel in human geography where there have long been calls to repatriate the ‘missing masses’ (Anderson & Harrison, 2010, p. 12) back into the social fold. In the Anthropocene, Haraway (2016, p. 67) argues that ‘the arts for living on a damaged planet demand sympoietic thinking and action’. ‘Sympoiesis’, Haraway (2016) explains, involves co-species ‘making’ worlds together. Haraway (2016, p. 29) offers a framework for co-existence, suggesting that co-habitation requires companion species to stay ‘with the trouble of complex worlding’. Humans, animals and technology collide (Haraway, 2016, p. 147). Within this knowledgeable messy muddle, ‘complex worldings’ created by humans and non-humans delineate the systems that govern everyday life. These complex worldings are ongoing and resultant of the co-creative activities of companion species, who are involved in processes of telling ‘permanently unfinished’ ‘kin-stories’. These kin-stories are constructed through ‘multispecies storytelling’, a process in which the ‘worldings’ of all companion species (human, soil, fungus) are ‘in play’. By creating these ‘kin-stories’, companion species are socially bonded, enacting a ‘response-ability’ as composters who exchange patterns and ‘become with’ each other. Haraway (2016, p. 29) argues that all species are response-able ‘for shaping conditions for multispecies flourishing’. The hyphenation of ‘response-able’ implies a meaning related to actors’ ability to ‘respond’ to their environment and the others they encounter. The notion of ‘response-ability’ differs from the conventional understanding of ‘responsibility’, relating to a sense of obligation to or having control over others and environs. In the context of the accelerating environmental and climate crisis, all species are response-able for actively rebuilding multispecies kinship relationships through ‘inventive connection’ practices. Companion species must ‘make trouble, to stir up potent response to devastating events, as well as to settle troubled waters and rebuild quiet places’ (Haraway, 2016, p. 1).

Nevertheless, all beings—human and non-human—are not ‘response-able’ to each other in the same ways. Acknowledging this diversity in agency amongst actors enables the inclusion of considerations of coupled environmental and social injustices exacerbated by the climate crisis (Mann, 2021) into an understanding of ‘response-ability’ in differing times and spaces. Haraway (2016, p. 114) states a need to actively cultivate ‘response-ability’ for ‘carrying meanings and materials across kinds’. Citizen science and other participatory processes, including community science, enable this cultivation of ‘response-ability’ by allowing shared meanings and empathetic understandings generated between multiple actors in the human and non-human world. ‘Response-able’ practices, as caring routines, will enable ‘multispecies recuperation’ in times of existential crisis. Cultivating responsibility is, therefore, conceptualised as a process that will not

only ensure that humans and non-humans can continue to live on a finite planet but as one that may enable co-species flourishing (Haraway, 2016).

The remainder of this paper explores the extent to which citizen science may cultivate such a sense of ‘responsibility’. Citizen science is an embedded participatory process. It involves embodied, emotional experiences that attune participants to their environments. Participants sometimes engage in embodied monitoring activities over prolonged periods, while they may often participate in several citizen science projects concurrently. The practice of citizen science is viewed within this paper through a lens that explores how citizen science is generative of response-ability. The remainder of this paper will explore the circulating kin stories present within narratives of citizen science. In sharing these narratives, this paper illuminates the potential of citizen science to enable a rich wallowing ‘in multispecies muddles’. This wallowing, generative of ‘joy, terror, and collective thinking’ could allow co-species to flourish in the Anthropocene (Haraway, 2016, p. 3). This undertaking, therefore, has a ‘catalytic validity’ (Lather, 1986).

2 | GATHERING CITIZEN SCIENCE KIN-MAKING STORIES

This research study, which provides insights into subjective narratives, is underpinned by the epitome that ‘it matters what stories we tell to tell other stories with’ (Haraway, 2016, p. 12). The narratives we construct, tell, re-tell and shape how we embody the world, including what practices we adopt and what our concerns are and will be. This phenomenologically (Merleau-Ponty, 1962) inspired study attends to participants’ lived experiences to gain deep understandings (van Manen, 2016) of and interpretive insights into what is at stake for citizen science participants in deciding to spend their time doing citizen science. A narrative analysis (Riessman, 1993) approach is used to analyse the affordances of citizen science for citizen science participants.

‘Citizen Crane’ monitoring team participants were involved in this ethnographic study via site visits and in-depth interviews. These teams were based at 11 locations on the River Crane, a River Thames tributary. Each group included two to three volunteers who lived or worked close to the site. Teams were recruited through an open process involving, for example, advertising on community notice boards near monitoring sites or via local special interest groups. No specialist ecological knowledge was required, as training was provided. Each team visited their designated site once a month to carry out monitoring activities. All members of the monitoring teams were invited to participate in this qualitative study via the project manager, who encouraged participants to make direct contact with me should they want to participate in the study. Table 1 gives details of the backgrounds of those participants (identified by pseudonyms) whose narratives are included in this article.

The study employed a sensuous methodology that foregrounds sensory ways of knowing and experiencing to make meaning within qualitative research (Pink, 2015). Participants were accompanied on visits to their monitoring sites as part

TABLE 1 Study participants’ profiles.

Participant	Number of citizen science projects	Self-classification of citizen science activity	Group memberships held	Employment status	Employment: Past or present
James	4	Leisure	Friend of Yeading Brook	Retired	Chemist
Gillian	1	Leisure/volunteering	Friends of Cranford Park	Retired	Dog walker
Rina	4	Work and hobby	Southeast Rivers Trust	Employed	Professional services, university
			London Amphibian and Reptile Group		
Phillip	1	Volunteering and hobby	Friends of Cranford Park	Employed	Transport for London
George	3	Volunteering and hobby	London Wildlife Trust Friends of the River Crane Environment Local Residence Association Royal Scout Group	Self-employed	Financial services

of an iterative research design. In a manner similar to what Lorimer (2014) describes as ‘companionable journeying’, this research approach enabled the interpretation of embodied, everyday citizen science practices and the re-telling of subjective, situated narratives of citizen science with a greater awareness of participants’ lived experiences (van Manen, 2016).

Gathered photographs, audio recordings of in-depth interviews and collected materials formed the basis of ‘thick descriptions’ (Geertz, 1973) of subjective citizen science experiences. In-depth, semi-structured interviews lasted between 30 and 80 minutes. Site visits with individual citizen science participants, usually half a day, together with pre- and post-visit email conversations, focused on gaining insight into the citizen science experience and what participants felt they gained from participating. Participants’ views of citizen science, including its purpose and how they identified with citizen science, social aspects of the experience, and their level of involvement in the scientific process, were also gained. Cardiff University granted ethical approval for this research, and following this process, participatory consent was given by each participant at the outset of the research process. During the research process, consent was renegotiated at several stages, for example, verbally before interviews, during site visits and in writing, through subsequent email conversations. This ensured that participants were comfortable knowing their participation was voluntary and could be withdrawn at any time.

The analytical approach taken was one of poetic structure narrative analysis (Dunkley, 2018b), which draws upon methodologies employed by Gee (1991) and Riessman (1990, 1993). This approach pays attention to speech as poetry, noting form, structure, linguistic and poetic devices, and tone, attending to the participant’s plot, as revealed through the interview process. Poetic structure narrative analysis requires listening, re-listening and re-telling participants’ stories in ways that are true to the teller’s original intentions. In this re-telling lies a catalytic validity (Lather, 1986) in terms of understanding human and non-human relationships, based on the power of kin stories (Haraway, 2016) to function as wayfaring (Ingold, 2011) instruments that may help us find pathways to more sustainable futures.

3 | WADING THROUGH CITIZEN SCIENCE IN THE MULTISPECIES MUDDLE

Citizen Crane, the citizen science project that is the focus of this paper, is based around the River Thames tributaries of the Crane and Yeading Brook in West London. The project is coordinated by the Zoological Society of London, Friends of River Crane Environment and Frog Environmental. This water quality monitoring project was established through funding from Thames Water following a major pollution incident in 2011, which devastated life in the middle and lower reaches of the river (Crane River Partnership, 2016). Each month, participants monitor the river in three ways on the third weekend, using a ‘kick/sweep sampling’ technique developed through the Anglers’ Association Riverfly Monitoring Initiative, collecting water samples to monitor ammonia and phosphate levels and measuring flow. This approach enables tactile engagement with the river to observe the water, its movement and its inhabitants. Participants don a pair of waders to collect samples analysed on the riverbank in the case of the invertebrate identification task. Each monitoring group comprises two or three individuals, while the entire group meets at an annual forum.

The narratives of five Citizen Crane participants, James, Gillian, Rina, Phillip and George, are presented in the following section to substantiate the six stages of the ecological kin-making through a citizen science analytical framework (Figure 1). These six stages identified within the Citizen Crane project build upon one another in an ongoing environmental consciousness-raising process that enhances the participants’ ecological kinship relationships through participating. These six stages are: encountering the river, recognising the non-human world, riverbank identification, developing a sense of responsibility, enacting responsibility, and enhancing ecological kinship.

3.1 | Stage 1—Getting in the river: Encountering, orienting and acknowledging the river and its critters

James, a retired chemist and Friend of Yeading Brook, has participated in Citizen Crane. In describing his relationship with the river, he underscores his embodied encounters with it:

I’m always in the river, with the waders and the groups, and you know, when I was 10 years old, I used to be going out with my friends with my fishing nets and playing in the river here, so it seems like, I’ve come back to, what I was doing as a child.

Several participants acknowledged the childlike joy of getting in the river and discovering invertebrates for the first time. James's narrative shows how interaction or encounters with non-human species creates the conditions for novel ecological insights and experiences. Through conscious orientation (Simonsen, 2013), he extends himself to become familiar with his local river over his life course. As a long-standing resident, he frames himself in his narrative as a conduit, connecting local human and non-human dwellers in his local environment. Through embodied citizen science participation, he encounters critters and humans to benefit the river field (Haraway, 2016) and the riparian landscape's local human and non-human inhabitants. James seeks to pass on the joy of getting in the river to others. He wants to share this joyful experience with children, believing that opportunities to interact with the river may enhance ecological learning. With the 'Friends of the Yeading Brook' group, he has put the material infrastructure needed to facilitate such encounters—a sampling platform and a gravel bed—which means that 'now we get even little children in the river'. In discussing the benefits of this, James states, 'I think the more we can encourage children to play in the river and investigate and learn, I think it would make a big difference, but then I'd want the river to be cleaner!' He also discusses the importance of nurturing children's interest in the citizen science invertebrate samples collected, seeing attending to the river and learning as inherently connected. He states:

I've had little [children stop] ... when you do a sample, and they're looking in the tray, and then the dog is licking the water up! I think they're showing an interest, and more often, they're interested in the fish that we caught than the insects, but I think that's fine. At least they've learnt something.

Within James's narrative, there is a sense of how vital multispecies muddling (Haraway, 2016) is to ecological learning. He illuminates how 'access to the river for children' is essential and generative of non-violent relationships with the river (Butler, 2020). James cares for the river. He is saddened by the slow violence enacted upon its inhabitants (Butler, 2020): 'We have been seeing a slow deterioration in the results on our part of the river, and it's a bit of a shame'. He describes the river invertebrates as an effective indicator of river health, working with a web of Citizen Crane actors to reveal and improve the river's health.

Using a metaphor to describe the effects of pollution, James designates the river invertebrates as pollution's 'footprint of what it [the river's health] has been like'. James enacts his response-ability (Haraway, 2016) through his provision of local knowledge and his regular monitoring of the section of the river, which is part of his everyday life. He does not believe this level of monitoring would be possible at a regulatory level without citizen science. He describes himself and others on the project team as 'first responders', stating that 'because we're either sampling in the river, or working on the river, we often get a chance to see pollution incidents first-hand. And we can report them, and they can log them and come out'. James believes that through monitoring, sampling, and sharing information about the river's health with Thames Water, he enacts his response-ability (Haraway, 2016) to improve the river. He sees Citizen Crane as having several 'layers' that collectively identify local pollution and support water pollution remediation. His long-term participation in Citizen Crane is driven by his desire to see the river's health improve. Through his interactions with the web of actors involved in the project to collect and analyse data every month, he describes that 'you get into a routine, and you get [to be] part of the project', where 'we're hopefully going to improve things' that keeps him involved. When reflecting on his role in the river's life, he discloses his frustration with what he sees as the slowness of local authorities to act on research results to improve the river's health. In contrast, recent improvements in the river's health have brought hope in a context of 'gradual decline'.

James's narrative allows us to see how wading into the river, as part of a citizen science project, can encourage listening to and hearing multispecies stories (Haraway, 2016) of waterways, which may aid the realisation of interrelationality. As Simonsen (2013, p. 12) argues, moving bodies are always "measuring" space in constructing a meaningful world'. Through this example of the praxis of citizen science, it is possible to grasp how humans, non-humans and space 'affect' and shape one another. In what Simonsen (2013) might describe as an orientation act, citizen science participants become familiar with non-humans and broader environments.

3.2 | Stages two and three—Recognising non-human kin, species identification on the riverbank

Butler (2020) argues that non-violent ethics are only possible if humans can 'name' and 'know' the living creatures who will be killed. A command not to kill cannot be understood unless the being to be killed is considered alive in the first place. Lives must also be valued and regarded equally 'grievable' amongst diverse human and non-human

communities. The loss of life must be considered a loss that matters. Comparable to Butler's (2020) concern with the extent to which lives are grievable, Haraway (2016) emphasises the significance of grieving with and mourning companion species as the root of sustainable, informed, practical action. Through citizen science, participants understand the river as alive with critters upon which all other river corridor dwellers rely. Participants come to know the river and know and name the critters living in it. Citizen science plays an essential role in protecting the river's and its inhabitants' health.

In a context wherein the River Crane's health was in constant decline, a confrontation with ecological violence happened through citizen science on the riverbank, where participants may grieve the loss of river life or their memories of the livelier rivers of their childhoods. Through the citizen science process, river dwellers and the river itself becomes known and therefore 'grievable', while mourning is necessary and generative of practical action as a response (Haraway, 2016). As a project resulting from a decision to pollute the River Crane, Citizen Crane is the result of a decision that implies that the lives of the river and its inhabitants were considered 'ungrievable' (Butler, 2020). Citizen Crane is thus a transformative project through the impacts of monitoring activities on river health through the potential of the process to counteract viewing the lives of river inhabitants as beyond empathetic engagement.

The potential of Citizen Crane to work on people, attuning them to the river, is demonstrated within Gillian's narrative. Gillian, a dog walker living in Battersea, London, described her love of the river Crane, which runs through Cranford Park underneath a 'Wind in the Willows' bridge. She had recently completed her Citizen Crane training in this section of the river, which her dogs also love. In the summer, she says, 'everybody goes in the river'. Nevertheless, until she was 'walking through the river' during the training, she had not realised 'the incredible life that's there'. Gillian describes the kit—waders, wellies, a net, washing up bowl and magnifying glass, a 'little identification booklet', and a 'Riverfly Partnership' card on protecting yourself from the risk of leptospirosis infection. Identifying the 'little critters' in the river, necessary for assessing the river's health is intriguing, disquieting and 'the most fun' for Gillian. She names and describes the critters, 'You actually go in there, and you find little Mayfly larvae ... three different larvae and freshwater shrimp, which I didn't even know we had, freshwater shrimp ... there was one, it makes its little coat of twigs and bric-a-brac'. She describes the process of 'going into waterweed, with our nets, and that's when we caught the sticklebacks'. They stay in the waterweeds 'cause they're safer from bigger fish'. She says there is 'nothing like getting in the river itself, getting them out [invertebrates] and actually looking at them and identifying them'. She describes how Citizen Crane enabled her to 'reconnect with childhood'. She was raised between England and America and explains how she 'used to catch newts (or salamanders), sticklebacks, tadpoles, and freshwater snails in these countries and collect things in the rock pools, like crabs and starfish and bring them home'. Somewhat mournfully, she recounts, 'it was quite exciting ... but didn't go into that field ... I wish I had, in a way'.

Reminiscent of Haraway's (2016) accounts of citizen science participants' experiences as part of the Transpecies Pigeon Project, the novel awareness that Gillian gains leads to a 'response-ability', a process Haraway (2016) defines as 'dwelling with loss' to find its meaning. Gillian describes her sense of response-ability via a narrative concerning her companion species—her dogs. She states:

There are certain parts where all the dogs go and play, and you think you're disturbing that little ecosystem there ... stepping on them. You can't really hurt them 'cause they're so tiny ... but they can't swim away ... but they probably don't congregate there because it's probably too busy for them. They move on.

A broader way Gillian feels she enacts response-ability is in her role as one of the 'field people' who 'gives [Citizen Crane organisers] the data [to analyse]'. For Gillian, taking part in Citizen Crane is a way of giving 'something back to the park' and a process through which she enacts a response-ability for human and non-human interconnectedness. 'Stopping pollution' and ensuring the river does not become 'stagnant' is essential to her, as Gillian feels she can influence these areas through ongoing monitoring activities. She describes gaining a:

Self-satisfaction that the river is clean. Because I walk in it with these [the dogs], in the summertime... the dogs are going in it ... 'cause there's all sorts of things, the dogs will pick up. ... So, you like to know it's clean ... 'cause they drink it, they swim in it. And everybody else, when you think about it ... 'cause, in the summer, children play in it. They could at least warn the public if something was leaking into it.

Gillian affirms her love for the river and the park, recognising the symbiotic benefits of river protection through Citizen Crane. Understanding human and non-human 'response-ability' (Haraway, 2016) is the basis for strengthening

existing bonds of reciprocity and developing a more profound sense of obligation and agency in the river's life. For Gillian, as for several participants, knowing how to read the river's health is the basis of a caregiving kinship relationship with the river.

3.3 | Stages four and five—Subduing destruction through citizen science: Developing a sense of and enacting response-ability

Butler (2020, p. 65) stated that 'to subdue destruction is one of the most important affirmations of which we are capable in this world. It is the affirmation of this life, bound up with yours, and with the realm of the living: an affirmation caught up with a potential for destruction and its countervailing force'. Butler's (2020) 'ethics of nonviolence' provides a framework for understanding the actively orientated motivations for citizen science participation. In many narratives, participating in Citizen Crane is seen as a multispecies, co-productive, co-constitutive effort to subdue environmental damage. It is a process that resonates with Haraway's (2016) notion of composting, which provides a valuable metaphor for understanding how participants use their agency to 'stay with the trouble' and nourish and enrich the river, just as composting does for soil. Participants monitor while clearing and advocating (Johnson et al., 2014). Citizen science is an effort that seeks to enable rivers, humans and non-humans to thrive in challenging times. Gillian's narrative shows how citizen science might provide a framework for naming, knowing, equally valuing, and grieving non-human lives to determine whose lives matter (Butler, 2020).

Another participant, Rina, a Biodiversity and Landscape officer at a local university, sees active participation in citizen science as a process that enhances a deeper connection with the 'natural world':

I think when you're doing monitoring activity, I think you may be more aware of what's going on in that natural world; you're more actively taking part in that world. And finding out something about it. Whereas compared to maybe just a walk, through a park or along the riverside, when you can maybe appreciate aesthetically what's there. That's good for you as well in terms of your mental well-being. It may not go any further than that. I think we're taking that active step in doing something like monitoring in the river, or maybe doing something like helping create a new riverbank by putting in plants, by doing something which is slightly more involved in the habitat; I think you connect more to it.

The river runs through the university campus, and Rina has both a personal and professional interest in enhancing the response-ability of students. She is responsible for ensuring that her university, as a landholder, legally complies with species legislation while encouraging volunteer engagement. She acts as a conduit for students, university staff and local community members to participate in the project, seeking to promote a wider enactment of environmental 'response-ability' (Haraway, 2016) amongst these groups:

To actually take part in volunteering events around biodiversity, and gain experience, and get thinking about that local environment, and their effects on the local environment, and hopefully what they can do to ... well, when I say their effect, I mean everyone's effect what they can do to instigate it as well.

Rina's perspective here is evocative of Kimmerer's (2013, p. 239) question: 'Isn't this the purpose of education, to learn the nature of your own gifts and how to use them for good in the world?' Rina feels that participating in citizen science is an opportunity for 'shaping young minds' while, like several other participants, she mentions giving 'something back' to the local environment. She explains the benefits to students looking to gain biodiversity work experience for future employment opportunities. She also believes that student participants will have conversations with friends and family due to participating. Rina echoes the belief within the citizen science literature that enhanced scientific literacy, and citizen participation are generative of environmental action (McNew-Birren & Gaul-Stout, 2022). Her view is that understanding the impacts of river pollution may generate ecological caring. She also states that participation can help make people aware of what is expected in wildlife habitats and how to question when something goes wrong. Through this predictive narrative, Rina shares her hopes for participation in citizen science. She refers to progress in campaigns that have discouraged smoking by influencing social conventions as an example of the importance of mindset shifting to the river's health. Rina references the transformational capacity of citizen science:

I think that's probably one of my incentives, [involving students and creating environmental change through involvement]. I think as the project as a whole, my take on it again, because, obviously, it's not

the overall impetus. Obviously, the project hasn't just come from the university, we're just one of the partners, but I think the whole point of most environmental projects is to try and get change, real change on the ground with education, and getting that education to a point where, it's not, somebody being told this is what the situation is, not just somebody being aware in general. Not 'oh, this is bad for the environment' It's getting it to the point where it's instinctive, or they know about it, just as a background thing and kind of like, I guess smokers—even smokers know it's bad for their health etc. And they know it's bad for kids, and all sorts, and that message has gone through, from a big educational campaign, from it being perfectly acceptable to smoke to now being socially unacceptable to smoke, while people still do it. And what would be lovely is going from a point of view—I guess it's re-framing, as I think one of the talkers talked about, going from a point of view where people think of rivers and parts of our environment as rubbish dumps and open sewers. And it's not important to actually going to the point where, actually, these habitats are really important for the wildlife that I love. You know, if I want to see these birds, all these things that, all really link to the habitat and even if I'm not interested, really in going out and doing practical work on that habitat. I know that if I don't do this, this, this and this. Or I make sure these are done, I'm not impacting on that habitat, it's that kind of—it would be just good to have that, it would become a background knowledge, so it's not like you're trying to educate people, but it's known by everyone. Cause once everyone knows something, even if they don't actually want to participate, the hope is there won't want to make a situation worse.

The excerpt above shows that Rina remains engaged in citizen science because she believes there is potential for local and global environmental transformation through the project (Glaas et al., 2022). In reflecting upon what participating in citizen science means for her, Rina shares that:

The river itself has helped me connect more, I think, with that local community, and with that kind of culture that's there (in the town), which people may not necessarily see ... And I think often beaches, or for me anyway, certain natural features, make me connect more with a place.

An emergent effect of citizen science participation for Rina appears to be becoming 'rooted' in a new place by connecting to the non-human river and river dwellers (Butler, 2020). The need to feel a sense of 'rootedness' has long been understood (Weil, 1971). Through observing and caring for the river through the ritual engagement of citizen sciences, Rina's place affinities are made and sustained, creating a sense of obligation from one party to the other. As a practice of ecological kin-making, Rina's narrative demonstrates how citizen science leads to human and non-human co-benefits.

3.4 | Stage six—Enhanced kinship (stories): Making friends with the river through ritual engagement

Citizen science is a scientific endeavour that benefits the river and human and non-human inhabitants and neighbours. As a kin-making praxis, citizen science can be a process that reconstitutes human–non-human relations by recognising each as being implicated in the flourishing of the other (Butler, 2020). The river and citizen science participants share 'roots' or ontological bonds within many narratives. It emerges from several narratives that developing and sustaining affinity bonds to the river was the reason for doing citizen science, revealing the underlying effects of emotional spatialities (Bondi, 2005). Connecting to the river enables Phillip, a bus driver and a Friend of Cranford Park, to find an emotional place connection (Milligan et al., 2006). He returned to London from America some years ago during the 2008 recession. He described how a sense of rootlessness and estrangement was connected to his desire to participate in Citizen Crane. He had left friends behind in America and wanted to bond to the new place he now found himself—where the river was a vital part of his local park, and the park an essential part of the place. He describes this in an emotional sense. 'Individuals move self-consciously to work upon their emotions' (Conradson, 2006, p. 108), while people mobilise and relocate to manage their feelings reflexively. In Phillip's case, joining a Friends group and participating in Citizen Crane is a movement through which he can 'work upon' his emotions (Conradson, 2006). It is a way of staving off homesickness for where he would instead be living.

Connecting with the river helps him 'settle' in the area where he struggled to feel an emotional connection strong enough to call home because, as he put it, 'home is where the heart is'. Phillip craves intimacy, togetherness and

attachment: 'home can be where you feel it is ... not where you were born, or where your family is'. As Ingold (2011, p. 154) states, Phillip seems to intuit that, 'through living with it, the landscape becomes a part of us, just as we are part of it'. Participating in river monitoring is perhaps a way of filling in for kinship lost through moving continents. In his narrative, he shares that he takes part in Citizen Crane 'because it's in the park', which he describes as feeling like a 'little oasis of countryside' when he walks through it. His knowledge of Cranford Park's history gained through participation and his wider involvement with the Friends of Cranford Park, is extensive. The desire to care for the river runs throughout Phillip's narrative. He states: 'I knew about the pollution problems that we had there ... so, I'm interested to see that the river's cleaned up, and we get fish and other wildlife back into the area'. He wants 'to see the park preserved, and the wildlife that goes with it', which is why he participates in Citizen Crane.

The 'recurrent ritual' of citizen science provides 'security and a sense of personal connection individual and the collective' (Milligan et al., 2006, p. 58). Phillip is aware of this, as demonstrated in the below excerpt, where despite the discomfort of citizen science, participants were committed to their part in the process. Phillip says that he keeps on participating because, if he stopped, he would be 'letting the side down'. Phillip says that after a Sunday shift at work:

I'm tired ... really; I'd like to put my feet up ... sometimes we walk to the local pub and have a Sunday roast and a pint of beer, and that's really what I want to do. Sometimes I really don't want to go up to the river ... if it's raining, or this time of year, when it's particularly cold ... but then again, I say to myself, 'I'm making a useful contribution ... they're relying on me to do that, and unless I've got a really good reason, I'm gonna do it'.

Similarly, Rina also discussed the importance of 'getting people into the rhythm of it (citizen science participation)' as she explained the impacts of delays in data reporting. This rhythm, she argues, needs to be 'built up'. However, for many participants, a strong sense of response-ability for involvement in the ongoing practice of ecological kin-making, delineated in the praxis continuity symbolised in Figure 1, is deeply rooted and appears to function as a process of recurrent renewal and environmental enhancement. George works in financial services and is a voluntary Nature Reserve Manager for the London Wildlife Trust's Yeading Brook Meadows, a stretch of land next to the riverside where he leads monitoring activities. For over 30 years, he has volunteered with LWT, and through this role, he became involved with Citizen Crane. His motivation for collecting citizen science data is to help identify what is needed locally to support the river.

'Having been roaming over those fields since I was old enough to be let out on my own sort of thing, and that was five or six ... in those days ...', he says, 'I just wanted to know more about what the actual food chain was affected by. And I thought if it was a way of, you know ... complimenting the information that people had about the place ... cause you know, we fought over the years for more resources to be over there. You only get those if you've got interested people to tell them what's needed'.

Monitoring through Citizen Crane is a way of having local control, using local knowledge to manage the river, rather than the external imposition of ideas. George is one of three volunteers who volunteer because of their interest in their local space.

Inhabiting space is an actual and imaginative wayfaring process (Ingold, 2011) for humans and non-humans. Taking up space is how people come to 'feel at home' in an environment. It is also a process wherein people develop affective connections to environments. Citizen Science can be considered a symbiotic process akin to what Ingold (2011) talks of as 'wayfarers' 'making' knowledge while also making the world. Wayfaring is an 'improvisatory movement—of "going along" or wayfaring—that is open-ended and knows no final destination'. Citizen science can be considered an improvisation that shapes humans, non-humans and their habitats through its infrastructures. George talks about his protective feelings toward the area around the river, framing this in the context of a historical relationship with the site, stating that he is:

Protective, I suppose, really ... In 1985 there was a threat to develop it, so that area over there, so I think, that's when we actually started a residents' association here. The Residents' Association sort of formed around the group that was trying to fight the development, which we successfully did ... and the Residents' Association is still in place today. In fact, I think I'm the sole survivor of the 10-strong Committee that started. I'm the secretary. Well, I think I am for everything else as well. But yeah, it really started from that, you know, that a place where I played as a child, and you know, we brought up three children here, and I used to take those over to play in it as well. You know, it was a really a case of protecting that area over there.'

Citizen Crane is a way of identifying pollution incidents. George explains his role: 'I sort of let people know what's happened with the Citizen Crane survey, and why ... cause there are ups and downs, other things like there can be pollution incidents'. George uses a metaphor referring to himself and his colleagues as 'small cogs in a much bigger wheel ... you've only got to have someone of the cogs not work, and the whole wheel grinds to a halt'. He highlights the importance of the allegorical wheel in gathering 'information' and raising awareness about river health:

So it's letting people know that the rivers are healthy and that if a little bit more, you know, measures were taken a bit further downstream ... then you know, species that can't get further up the Thames and into the tributaries as they used to could get back into. So, it's a way of letting people know the river's health, and it's a way of letting people know that, you know, measures can be taken to make them healthier.

George volunteers for many roles because he believes change is enacted through local action and citizen participation (Glaas et al., 2022; Kiss et al., 2022). Like his fellow site monitors, Peter and Joshua, the three participants are interested in protecting the future of the places they are deeply rooted in through all their volunteering actions. Like James, George's group and several others talk about informing passers-by and school groups, who stop to look in the tray. The participants are custodians of the river, holding and passing on their knowledge.

4 | CONCLUSIONS

This study has engaged with the work of relational thinkers (Kohn, 2013; Latour, 1993) and feminist scholars of care (Butler, 2020; Haraway, 2016; Kimmerer, 2013) to explore citizen science as an interrelational process. Citizen science emerges from the study as an attuned, ongoing caring practice in ecological kin-making (Butler, 2020; Haraway, 2016). New kinship relationships are formed, maintained and strengthened for co-species flourishing (Haraway, 2016). The study unveils the conditions via which ecological kin-making practices of citizen science enable individuals to realise their transformative agency in impacting the river's health. Concurrently, the agency of the non-human to affect participants (Conradson, 2006) and thus transform both participants and them 'selves' (Kohn, 2013) through citizen science is revealed.

It is a 'response-able' (Haraway, 2016) act that allows a reappraisal of caring for and being in the care of each other and the environment. This enactment of response-ability is life-sustaining and counters the renunciation of human–non-human independence and co-species estrangement (Hooks, 2008), resulting in never-ending conflict (Butler, 2020). Butler (2020) conceptualised the relations, provisions and co-dependencies between social beings and the natural environment's life-supporting infrastructure necessary for survival, growth and learning. Citizen science can be considered an infrastructure through which local people make kin through a social care practice. It is a process that reconstitutes human–non-human relations.

Citizen science can also be considered generative of posthuman anthropology. Its praxis enables participants to 'think like a forest', as (Kohn, 2013) has argued, necessary for survival in the Anthropocene. Through its combinations and muddling of technology, critters, humans, waders, water, river, authorities, organisations, labs and scientists, citizen science provides the infrastructure to facilitate participants' interactions with the river. Ecological kin-making through citizen science contributed to participants' positive health and well-being (Dunkley, 2019), fulfilling sentient desires enabling higher-order learning, and enhancing participants' sense of self-efficacy and self-esteem while benefiting the river's health by contributing to scientific endeavour. This paper's narratives of everyday emotional and ecologically conscious citizen science encounters deconstruct the 'defamiliarising pedagogic' (Kohn, 2013) process. More-than-human kinship relationships are developed and maintained through situated river monitoring practices. Citizen science involves donning 'clothing—the equipment, bodily accoutrements, and attributes' and attending to the river, amplifying for participants the 'living logics' of the river (Kohn, 2013, p. 215). Attuning to the river, critters in the water and absent fish become recognisable to those participating in water quality monitoring. Species interdependency becomes increasingly visible through the broader, prolonged engagement with the river and the critters that inhabit it. This process of attuning is sensory, emerging as novel, not only in the comprehension of other species and selves but also through the sensual process of seeing, feeling and hearing the river, which materialises as profound for the individuals within this ethnographic study.

By bringing the non-human world into focus, citizen science helps humans see and sense non-human selves worthy of defending (Butler, 2020). Non-human species become 'grievable' through citizen science processes. Mourning, Haraway (2016) states, helps us appreciate interdependence and interrelationality. In times of mass extinction, we must grieve, remember and learn to 'live with ghosts'. We do not have a dominant national frame to mourn for lost fish and

rivers, nor is it common for people to talk about rivers in a language that recognises a need to grieve for the non-human. Practices of ecological caring through citizen science emerge from the subjective narratives presented herein as a different relationality with the environment, enabling an alternate relationship with the non-human. As many other participants alluded to, such processes of ecological caring may not always be pleasant. Ecological kin-making through citizen science can be toil and trouble. It is getting wet, cold, tired and muddy. Caring relationships ‘can be a way of getting wrecked, time and again, by the demands of a wailing and hungry creature’ (Butler, 2020, p. 50). Staying with the trouble is tiring, but a response-able (Haraway, 2016) caring and ultimately loving act.

The river monitoring project, the focus of this qualitative study, emerged as an enabler of self-directed ecopedagogy due to its capacity to enable transformative environmental learning for individuals who participated. It enabled embodied encounters with the non-human world (Stewart, 2018), which is increasingly valued for the mutual benefits to both human and planetary health that such encounters result in (Barragan-Jason et al., 2022). Citizen science emerges from this study as having a ‘catalytic validity’ (Lather, 1986); its value is within its capacity to create transformational change—a change that happens as multiple human and non-human interspecies relationships gather scientific knowledge. As a process, it requires humans to dwell (Ingold, 2011) in the non-human world. This enables ‘world making’ as a wayfaring (Ingold, 2011) praxis through which human and non-human relationships are reconstituted. Citizen science wayfaring is participant-led, lifelong, slow ecopedagogy (Payne, 2014), where relationships between human and non-human worlds are slowly built. This process itself enables co-species flourishing (Haraway, 2016). It is concerned with long-term communion and recognises co-dependency within ecosystems and other species residing within those ecosystems (Butler, 2020). Rather than superficial, fleeting ‘connections to nature’, whereby we look to engage for benefits for humans alone, citizen science may be a way of moving us toward a less-extractive way of relating to ‘nature’, beyond human exceptionalism toward the relational understanding that ‘we are nature’ (Porto & Kroeger, 2020). In a time of socio-ecological urgency, this slow approach is still necessary. As Latour (2017a, p. 17) maintains, though we may be told those comparative anthropologic explorations are ‘too late because Gaia is irrupting too urgently ... it is because of the urgency that we must begin to reflect slowly’, a slow reflection that is enabled via ecological kin-making through citizen science.

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DATA AVAILABILITY STATEMENT

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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