SHORT-PAPER

Towards Reciprocity: Mediating Human-Nature Relations Through HCI

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Abstract

As concerns of ecological degradation intensify, digital technologies are increasingly explored for their potential to inspire environmental concern and deepen human-nature relationships. In Human-Computer Interaction (HCI), many nature-focused technologies still reflect deeply extractive anthropocentric views that separate humans from nature. However, there is now growing interest in designing from alternative orientations (e.g., more-than-human approaches and relational ontologies), to move towards more inclusive forms of nature interaction. This paper reports insights from an academic workshop involving HCI researchers and practitioners, who explored these tensions through design activities for diverse nature spaces. We identify key challenges and opportunities for HCI in supporting more meaningful engagements with nature, emphasizing under-explored application areas, and proposing future research directions. We argue that challenging existing temporal and methodological constraints embedded in HCI design processes is essential to fostering reciprocity, to create mutually responsive relationships where human and non-human needs, rhythms, and agencies are acknowledged and respected.

CCS Concepts

• **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in HCI**.

Keywords

human-nature relations, digital technologies, design workshop

1 Introduction

Digital technologies are transforming our engagement with nature. Since the global pandemic, studies suggest that women, younger people, and people with greater socio-economic means spend more time in nature than before 2020 [49]. Digital technologies are increasingly involved in these experiences, creating opportunities for people to notice, learn, and interact with nature [29, 56], thus promoting interest in HCI to contribute to deepening this relationship. However, many existing digital nature engagement tools continue to embody the view of nature as a resource to be consumed by humans for their entertainment, healing or self-betterment [16]. This perspective - associated with modernity and the Enlightenment - is increasingly considered problematic and there is a growing shift towards human-nature relationality, and applying technology to foster more harmonious relationships with nature [3, 11, 35].

We conducted a workshop at an academic conference (OzCHI '24: 36th Australasian Conference on Human-Computer Interaction) to explore the diversity of human-nature relations and their implications for HCI [37]. The orientations examined included psychological perspectives that encouraged diverse forms of nature engagement [56]; more-than-human approaches emphasizing the interdependence between humans and other forms and processes of life [17, 36]; and Indigenous ontologies that have long included relational understandings and practices, including oral traditions such as storytelling to transmit phenological and ecological knowledge [17, 28, 48]. The workshop aimed to (1) map underexplored roles and opportunities for digital technologies in mediating human-nature relations, (2) identify current and emerging challenges for HCI in adopting and supporting diverse perspectives, and (3) identify future research directions to address these challenges. In this paper, we report insights generated in the workshop, three design scenarios for technology to encourage reciprocity between humans and nature, and practical challenges encountered in applying nature-technology research in the real-world. We particularly reflect on the interplay between nature's agency and temporality, and argue that fostering respectful reciprocity with nature requires actively challenging the temporal constraints embedded in the structures that currently shape design.

2 HCI and Human-Nature Relations

HCI researchers increasingly study how digital technologies can facilitate nature interaction [4, 22, 24, 27, 31, 42]. A range of reviews of such work, identify various roles for technologies in encouraging people's nature engagement [56], fostering environmental concern and sustainability action [50], and promoting health and well-being [43]. Recent reviews also identify strategies (e.g., recognizing, exploring, empowering) that guide the design of artifacts to mediate human-nature relationships, and observe that few approaches support nature's agency or advocate for equitable human-nature relations [29]. Indeed, while aiming to foster nature interaction, many

tools remain grounded in Western design traditions that are human-centric and commodify nature [16]. First Nations authors have long called for attention to human responsibilities in reciprocal interactions between humans and nature [13] and, with increased recognition of the way commodification participates in human-nature disconnects, HCI has begun to engage with non-anthropocentric approaches that position nature more centrally in the design process [16, 26]. Various lenses have emerged in this transition to shape designers' understandings of technologically mediated nature interactions. These include more-than-human approaches [26, 36] and relational ontologies (e.g., indigenous perspectives and ethics of care) that encourage re-orientation of design traditions towards reciprocity [1, 11, 44]. Collectively, these views support the development of technologies that enhance awareness of non-humans, facilitate inter-species communication, promote co-existence, and embed principles of care, conservation, and sustainability within digital design [3, 11, 15, 18–20, 25, 39, 42, 52].

3 Method

Our workshop's primary aim was to examine how HCI can embody diverse perspectives on human-nature relations, through brainstorming sessions, design activities involving the proposal of digital interventions that could facilitate meaningful and reciprocal interactions with nature in the vicinity of the conference venue, and multi-disciplinary discussions. The workshop's participants constituted fourteen HCI researchers and practitioners, including members from Māori communities (2), PhD students (4), HCI researchers/lecturers (5), and professors of HCI and related sub-fields (3). All participants currently live or work in Australia and New Zealand, and drew on their lived experiences and/or cultural identities in interpreting and discussing their experiences during the workshop. We selected participants based on expressions of interest (EOIs) that outlined their prior and current work; thus most had experience designing and developing digital technologies for human-nature experiences. However, they had diverse orientations to nature and human-nature relations.

3.1 Workshop Procedure

The workshop was organised as a full-day in-person event comprising four main activities.

(1) An initial brainstorming session to map participants' interpretations of "nature" and "nature engagement", to facilitate forming groups based on perspectives on human-nature relations that participants sought to explore during the workshop.

(2) A semi-guided walk in urban nature settings near the conference venue at the University of Queensland (UQ), Brisbane, Australia[1]. Participants walked in various locations, including a recreational park surrounding a lake, a bush tucker garden featuring native Australian plants, and a teaching garden that replicates a rain forest environment with few structured paths (see Figure 1). They were asked to explore

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[1]Map of the workshop venue: https://maps.uq.edu.au/?zoom=15&campusId=406&lat=-27.497294100340177&lng=153.01141737377685&zLevel=1. The areas explored by participants include UQ Lakes, Bush Tucker Garden, Alumni Teaching Garden, and the surrounding areas.

sites to identify opportunities or challenges for technology relating, but not limited to, the site and the perspectives that group-members shared in common. Prompted by worksheets (Appendix A), online resources and photographs already collected by the workshop organisers, groups wrote notes and took photographs as inspiration for designing digital tools that might be used in this space and as material for subsequent discussions.

(3) A speculative design activity in which each group ideated opportunities for technological intervention around the site. Each group generated several ideas, and developed one as a low-fidelity physical prototype, along with a scenario in which one or more technologies might support people building more harmonious relationships with nature. Each group presented their scenario and prototype, focusing on their chosen problem areas, reasoning, and solutions.

(4) All participants then assembled for a multi-disciplinary discussion reflecting on themes that arose during the previous design activity, current challenges for HCI as a discipline and future directions of research.

(a) The lake and conference venue area.

(b) Animals inhabiting the recreational park and lake area

(c) Participants exploring the teaching garden

(d) The entrance to the Bush tucker garden

Figure 1: Landscapes of the UQ Lakes Precinct and surrounding areas that were explored by participants.

3.2 Data Collection and Analysis

We photographed notes written on whiteboards and post-it notes, worksheet responses, and design prototypes and materials. We began analysis during the workshop, in the brainstorming and discussion rounds, which identified, grouped, and expanded key ideas. The facilitators refined and further organised these groupings after the workshop.

4 Findings

Participants formed three groups, thus, we organise our account by first summarising each group's activities, values related to technology and nature engagement, and resulting design ideas. Next, we describe three key roles for technology in mediating human-nature relations emerging from these activities. Finally, we discuss challenges for HCI in designing, deploying, and integrating nature-technologies in practice, drawing attention to trends and future research directions.

4.1 Digital Nature Scenarios

From our initial brainstorming, we identified three perspectives which provided a point of departure for the three groups. These included interpretations of: (1) People as "other", (2) sustainability and climate consciousness, and (3) motivating and informing direct nature engagement.

4.1.1 People as "Other". Group 1 (G1) aimed to foster deeper understanding of animals' perspectives, while encouraging people to notice how nature operates at its own temporal rhythms rather than those imposed by humans. Many of the group's early design ideas - "lizard alert": a wearable or mobile app that would alert users to lizards roaming in their vicinity; "walking without time": an application that blocked out reminders of human schedules on the users' mobile devices; and "layers over time": a digital tool that revealed how nature had changed over different points of time - sought to demonstrate how animals structure their lives differently from the time-based schedules of humans. Reflecting on the perspectives of animals encountered during the walk, the group then shifted to consider humans as "other". It is worth mentioning here, that these ideas were influenced, at least in part, by a Mātauranga Māori perspective, represented and embedded in the practices of several participants in G1 (and G2), who were either of Indigenous heritage or had turned to these perspectives in their attempts to interpret their felt experiences.

A final scenario, narrated entirely from the perspectives of the animals involved, follows "Lizzie the lizard", "Torty the tortoise", and "Ducky the duck" as they notice and respond to a student walking through the park where they live as he journeys to class (see Figure 2). The story describes the different ways in which animals view us, developing affinities with some individuals with care-taking or playful-type interactions, but hiding from other louder, clumsier, or less responsive individuals. For example, the ducks saw people as food distributors, while the tortoises followed the wakes left by the ducks. The student was alerted to Lizzie's presence through his "lizard alert" app, yet the lizards remained mostly unbothered or even hiding from humans. Other ideas included keeping nature

free of human rubbish and discovering ways to capture the sensory experience of nature (e.g., developing a "bat perfume").

Figure 2: Lego model created by Group 1 depicting how the animals residing at UQ Lakes encounter a student walking through their habitat.

4.1.2   Sustainability and Climate Consciousness. Group 2 (G2) presented a scenario of a futuristic society where technology advancements were used to help humans converse with nature and develop more sustainable ways of living. The group initially focused on technology's role in care and custodianship of nature, constructive climate imaginaries, and in transferring knowledge to nurture profound appreciation for the wilderness. Their ideas included cultivating rich sensory interplay within augmented environments, such as soundscapes enhanced through augmented reality (AR) and spatial audio, for the evocative transmission of knowledge, and playful mobiles experiences for learning about nature. The group's final scenario described the environment of UQ Lakes several hundred years into the future when, in response to environmental change, humans evolved by rewilding themselves and becoming more like other animals to reconnect with nature (see Figure 3). Here, technological innovations enable humans not just to adapt to new environments, but to deepen their comprehension, enhance communication, and harmoniously co-exist with nature.

4.1.3   Motivating and Informing Direct Nature Engagement. The scenario developed by Group 3 (G3) examined how visitors could have more meaningful "direct experiences of nature" [56], while remaining aligned to a site's envisioned purposes. The group initially focused on diverse approaches to direct nature engagement, particularly in navigating and developing deeper understandings by engaging with diverse knowledge systems. Thus, their early ideas included sharing life-cycle processes of plants; "grasswall" - a robotic installation to support the needs of plants and animals and reveal hidden elements of the environment to visitors; audio guides that did not require phones; QR codes and other signage options to help better explore the site; and ways to capture and share nature photos with others. Their scenario explored the potential for an Indigenous-owned business to provide meals to students incorporating ingredients from the bush tucker garden, using a menu app that educates diners about the garden (see Figure 4). The proposal

Figure 3: Lego model created by Group 2 depicting the future environment of UQ Lakes and residents' use of technology to adapt to the environment.

sought to provide a stimulating visitor experience that effectively shared Indigenous knowledge and addressed existing barriers at the garden, such as limited navigational assistance, difficulties in interpreting signage, and visitors' lack of understanding of the role of a bush tucker garden as well as native Australian flora and fauna.

Figure 4: Figure 4: Lego model created by Group 3 depicting how staff and students use their phones to explore the bush tucker garden and select foods from a menu.

4.2   Opportunities for Nature-Technologies

Central to the scenarios discussed by each group was a desire to pursue non-extractive relationships with nature. In this section, we describe three emergent themes about roles for digital technologies in enabling transition from human-centric paradigms to cultivate more reciprocal relationships between humans and nature.

4.2.1   Fostering Empathy and Understanding Towards Nature. Human-centric views are often reinforced by a limited understanding of the lives of other species [30]. Technology can play a vital role in fostering awareness of more-than-human actors by revealing aspects of nature that otherwise go unnoticed, supporting learning

about more-than-human experiences, and helping people overcome nature-related fears that can shape negative or avoidance attitudes. Participants' designs and concepts, including G1's "walking without time", "layers over time", "hazard warnings" and "lizard alert"; and G3's "grasswall" and "life cycle information platform", encourage visitors to notice hidden or overlooked elements of nature, to develop nuanced understandings of nature's complex and often invisible processes. Similarly, G2's scenario demonstrates technology's role in people's appreciation of a more-than-human lens and pursuit of ecologically considerate ways of living.

4.2.2 Amplifying the Voices of More-Than-Human Actors. Digital technologies, including those designed for nature engagement, overwhelmingly centre human needs (e.g., a recent review by Webber et al. [56] exemplifies a plethora of digital tools designed to assist humans in sensing, capturing, learning, analysing, enjoying shaping, and utilising nature), however, achieving more sustainable futures requires greater consideration and representation of the needs of other species. G1's ideas draw attention to the agency of more-than-human actors (e.g., "Lizzie the lizard", "Torty the tortoise", and "Ducky the duck") in how they interact with humans and other animals and choose with whom they invest time in their environment. Here, the technologies provide ways for people to become more attuned to the diverse perspectives and rhythms of more-than-human actors in the environments they pass through. These ideas were echoed in G1's "lizard alert", "walking without time", and "layers over time" that encourage people to notice nature's own temporal rhythms, beyond those imposed by humans; and again, in G2's digital nature scenario where technology acts as a medium through which people might converse with nature.

4.2.3 Representing Knowledge from Diverse Perspectives. Certain paradigms (e.g., Western Science, nature-as-resource etc.,) tend to structure visitors' engagements in nature, yet fostering multiple ways to understand nature has significant value. More flexibility to engage with different paradigms can promote a deeper sense of place, belonging, environmental responsibility, and stewardship. Participants considered technology as a critical mechanism for this shift, particularly for gathering, interpreting, and communicating diverse forms of knowledge to non-expert audiences. G3's re-imagining of the bush tucker garden utilized technology to convey Indigenous knowledge in embodied and sensory engagement. Similarly, their "life cycle information platform", audio guides, QR codes, and other signage options demonstrate how Western science can be integrated in settings of cultural significance to First Nations. Additionally, G1's "walk without time" and "layers over time" sought to embed Indigenous logics about temporality within the teaching garden and recreational park - spaces traditionally rooted in Western scientific and experiential paradigms, while G2's ideas aimed to represent knowledge from more-than-human perspectives and promote inclusive and pluralistic understanding of nature. However, it can be difficult to represent different perspectives together and foster "both-ways learning" [5].

4.3 Challenges for HCI

Three key challenges for HCI, in mediating human-nature relations, were carried in discussions throughout the workshop.

4.3.1 Reducing Technology's Experiential and Environmental Burdens. Participants expressed desires to reduce the salience of technology in nature-based settings, citing concerns that digital technologies often contribute to distraction and detract from meaningful engagement with the environment. Whilst fading into the background of experiences with nature has long been mentioned [11, 27], design approaches continue to be technology-centric, primarily focusing on interactions between users and technological systems [27]. Many existing nature-technologies rely on sedentary, visually dominating experiences to capture users' interest [38]. Thus, even digital technologies intended to support nature engagement inadvertently shift users' attention from their interactions with nature towards the technological intervention. Design approaches must prioritize human-nature interactions and technology should serve to mediate, enable or enhance, not dominate, these relationships [27] thus the challenge for HCI lies in identifying and developing technologies that can facilitate less extractive human-nature engagement and manage the intrusiveness of human-technology interactions. Suggestions offered by participants sought to enhance other forms of sensorial experiences in nature, and included hands-free audio guides and augmented soundscapes, aligning with principles of ambient or calm technologies such as those discussed in [14, 40, 41]. These designs sought to move away from typical patterns of holding and visually engaging with a digital artefact and, instead, choose less disruptive interaction mediums.

Discussions also highlighted concerns around the material impacts of technological interventions in nature such as waste production, the consumption of resources such as water and energy during the development and deployment of nature-focused technologies, and the broader environmental footprint of the infrastructures required to support these systems. Participants emphasized that designers must take greater responsibility in minimizing these material costs, as without careful consideration, technologies intended to strengthen human-nature relationships risk contributing to the very degradation they seek to address. Suggestions included designing to utilize existing infrastructure and tools.

4.3.2 Involving More-Than-Human Actors. Important concerns emerged in design proposals and discussions related to including more-than-human stakeholders in design processes and ethically and respectfully empowering them as actors. Participants discussed the privacy and safety of non-human species, particularly when data is collected, stored, or shared without appropriate regulation or oversight. They also highlighted the potential impacts of monitoring technologies on animal well-being, which points to the need for continued work to include more-than-human actors in design, including further developing, evaluating, and refining relevant methods. The field of animal-computer interaction (ACI), though primarily focused on technologies to be *used by* non-human animals, offers directions for integrating knowledges and methods of the life sciences into design. This can serve to identify and understand the needs of animal stakeholders [51, 55], to include animals as co-designers and experts in their own experiences [54, 57], and to involve them consensually and ethically [32]. Design techniques that draw on diverse knowledges and ways of knowing, and are not so intertwined with human expectations of timing, can also be further expanded to understand and represent the interest and

agencies of flora [6], fauna [7], ecosystems and landscapes [2, 46]. Additionally, design principles, such as those of participatory design (PD), can promote mutual learning of emplaced practices, priorities, and design that is sensitive to the context as demonstrated in [19, 20]. We argue that for more ethical and respectful engagement, the design of nature technologies should more directly integrate these approaches and more responsibly and inclusively represent diverse knowledge systems and their temporal rhythms.

4.3.3 Trust and Institutional Restrictions. Our participants discussed the value of collaborations with subject matter experts, identifying potential for expansion and future directions of research in designing digital technologies to support pro-environmental activism, advocacy and for enhancing the voices of conservation organizations. In nature-HCI research, designers often collaborate with experts and knowledge-bearers including public nature organizations, conservation and advocacy groups, scientists, Indigenous experts and other holders of situated knowledge. Establishing trusting relationships with these groups is essential for ensuring the accuracy and relevance of designs, accessing diverse epistemologies, and for ensuring these are approached and represented ethically, with appropriate sensitivity. Concerns also arose regarding intellectual property, whose knowledge is represented in these designs, and who has, or should have permission to access and represent certain forms of knowledge, further emphasizing the need for long-standing relationships with knowledge-bearers for responsible representation. Yet, the time and care required for this trust-building is often incompatible with the accelerated pace of academic research [53]. Institutional research timelines and deliverable-driven models limit the ability of researchers to engage meaningfully with these organizations. In addition, nature-focused HCI research often struggles to secure adequate funding. Public nature organizations also typically lack the financial resources to engage in sustained collaboration with academic institutions, demonstrating how existing systemic barriers hinder progress in this area.

We sought to engage First Nations groups local to the conference venue by inviting them to attend the workshop to contribute their knowledge and guide participants' nature exploration. However, the time-frame of our efforts to communicate and establish relationships with these groups was incompatible with the demands of our institutional processes and, thus, we were unable to involve Indigenous knowledge holders as workshop facilitators. This shortcoming reflects the broader challenges for HCI that arise from established practices and common time-bound expectations that limit researchers' approaches to engaging meaningfully with representatives of diverse knowledge systems.

5 Discussion

Our findings are largely confirmatory, echoing more than two decades of HCI research in identifying under-explored applications of nature-technologies and exposing persistent barriers to fostering more reciprocal relationships with nature. The continued recurrence of these challenges suggests a deeper problem: that despite ongoing research efforts to engage designers in conversing with nature from the start of design (e.g., [9, 10, 14, 15, 21]), prevailing design traditions in HCI still encourage deeply extractive anthropocentric approaches to human-nature relationships. We

now reflect on these key challenges, discussing possible design directions to meaningfully direct future research efforts.

5.1 Reflections on Agency and Temporalities

We propose that designers' limited understanding and awareness of the interplay between nature's agency and temporality, illustrated in our workshop, indicates that we need to rethink understanding and design approaches when working with non-human entities. We need to be coming to "learn from them", not coming with "already knowing". Digital technologies and existing design processes are often structured by Western conceptions of time, embedding values of efficiency, productivity and control in planning and scheduling according to clocks and calendars [12, 15, 45]. Clocks and seasonal temporalities often structure human activities, yet the earth's rotation about its axis and around the sun are not nature's only cycles. When First Nations authors describe how humans should interact "at the right time" they refer to ecological, moral and spiritual cues [13] and acknowledge the emergent temporal properties of nature's many cycles with an inherent respect for an ecosystem's agency. We embedded Western values and priorities in relation to time throughout workshop planning and scheduling, exploratory methods and imaginings of nature-technologies, and this is problematic when they subjugate other values related to time.

Design direction: Designing to encourage users to adapt to ecological rhythms. To move towards reciprocity, we argue for an increased focus on designing technologies and processes that surrender to nature's agency, and help people exist in nature's temporalities. Tensions about temporality have long been raised in HCI and yet doggedly persist. We propose that designs that centre people enforce this rigidity by framing nature around human rhythms and temporalities. However, nature-focused technologies would be more attuned to nature's rhythms and help visiting humans also adjust to more-than-human temporalities.

5.2 Diverse Lenses in Nature-Centric Design

Different lenses for interpreting human-nature relations were interwoven throughout participants' discussions and activities. G1 began their activities aiming to design for the improved experience of human visitors to UQ Lakes, but later pivoted to represent the needs and experiences of animals inhabiting the site. This shift closely aligned with more-than-human design traditions [25, 26, 36] that recognize the need to involve more-than-human perspectives in fostering user reciprocity. The G3 scenario in the bush tucker garden invites incorporating Indigenous knowledge into the design. Western science shows that plants signal warnings or distress when they are being eaten [47]. Totemic and Dreaming relationships with species, in different Indigenous paradigms, determine taboos, rituals and practices that govern if, how and when specific flora and fauna are harvested, hunted or consumed [33, 34], and implicate appreciating nature's agency and dialogically engaging with nature's temporality [13, 15]. G2's scenario motivates for technology to assist humans in learning to better converse with nature by adopting the traits and mannerisms of other animals. This calls attention to how communicating with nature according to non-Western traditions and practices are distrusted as myth or pseudoscience, yet envisioned as ideal when achieved through technologies grounded

in Western thinking. Collectively, these reflections show the importance of actively representing multiple ways of knowing and relating to nature in design processes, to enable designers to interpret significant experiences through various lenses. By eliciting meaning from diverse forms of nature interaction, designers can offer broader opportunities for users to empathise and make sense with nature and move beyond restricted paradigms.

Design direction: Embed pluralistic ways of knowing into design. We suggest that intentionally directing designers to explore and adopt pluralistic approaches to nature-technology design, is a useful exercise to prompt more respectful and inclusive designs. In our workshop, each participant group brought together individuals with diverse knowledge bases, including expertise in HCI design practices, more-than-human design, Indigenous knowledge systems, and familiarity with local environments. The intentional composition ensured that multiple ways of knowing and relating to nature were actively represented in the design process, enabling participants to identify significant experiences and interpret them through a variety of lenses.

5.3 Temporal Constraints in Methods

As a key lesson from our workshop, we argue that to improve the validity of HCI research in relation to nature, we must circumvent or resist systemic temporal constraints. In section 4.3, we discuss how institutional processes incurred time overheads that limited our attempts to build trust and engage local First Nations groups as workshop facilitators. The workshop also followed a set schedule, adhering to the norms and expectations of planning and executing design activities at academic conferences. We included a three-hour segment for nature exploration to help situate designers in the environment targeted for design. Situating design in nature prompts developing technologies that are relevant and responsive to specific human-nature interactions. Moreover, directly engaging with a specific environment provides insights into how it operates, enabling designers to identify meaningful experiences that technology might support or enhance. It also allows designers to critically reflect on their emotional responses and assess how technology might support or interfere with the deeply affective qualities of nature experiences and be shaped by the "aliveness" of the atmosphere[9]. However, imposing fixed time limits on this activity inevitably confines experiencing the setting; for instance, visiting at different times of day or in different seasons would likely yield different sensory, affective and ecological experiences. The nature exploration proceeded during a brief dry interval in an otherwise rainy day and encounters and design ideation may have differed had participants ventured out in different weather, and the presence of other species or a different emotional tone may have led to emphasising different themes. Enforcing a predetermined, time-bound schedule suppresses nature's agency in authentic interactions and inadvertently restricts the nature scenarios that designers can respond to.

Design direction: Adopt methods that involve extended, situated design in nature. Methods for situating designers in nature have a longstanding presence in HCI literature (e.g., [8, 10, 14, 15, 21, 23]), and are valued for encouraging designers to attend to other species, whether these species are intended users or stakeholders in some other way. They also help uncover relationships that are vital

to developing many sorts of technologies, such as belonging to a community [10]. Despite their potential, the practice is not formally recognised, and rarely forms part of designing "everyday" technologies. Although designers of nature-technologies often intuitively recognize the value of exploring natural settings and may wish to extend their time in situ, other priorities intervene. In the case of our workshop, we were unusually fortunate to be able to conduct an extended nature walk. Often such intentions are thwarted by other academic priorities (e.g., research timelines and institutional schedules), lack of easy access, weather, and or practical hurdles. Without opportunities for focused, situated, designerly attention to specific nature interactions - including species and relations that are made possible by the site itself - it can be easy to fall into a trap of designing for generic or imagined nature experiences shaped by tropes and commonplace imaginaries.

6 Conclusion

In this paper, we presented insights from an academic workshop that brought together researchers and practitioners with diverse perspectives on technology and human-nature relations. Participants collaboratively explored current challenges and opportunities for HCI in mediating these relationships. Through site-specific design activities, the workshop generated speculative scenarios, identified under-explored areas of application, and surfaced existing barriers to meaningful nature engagement within the field. We offer our reflections on the interplay between nature's agency and temporality, and argue that promoting reciprocity and sustainable engagements with nature requires us to actively challenge, reconfigure, and work beyond the structural and temporal constraints that currently shape nature-HCI research.

Acknowledgments

References

[1] Yoko Akama, Penny Hagen, and Desna Whaanga-Schollum. 2019. Problematizing replicable design to practice respectful, reciprocal, and relational co-designing with indigenous people. *Design and Culture* (2019).
[2] Ferran Altarriba Bertran, Oğuz 'Oz' Buruk, and Juho Hamari. 2022. From-The-Wild: Towards Co-Designing For and From Nature. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts*. ACM, New Orleans LA USA, 1–7. https://doi.org/10.1145/3491101.3519811
[3] Ferran Altarriba Bertran, Oğuz 'Oz' Buruk, Jordi Márquez Puig, and Juho Hamari. 2025. How Can Interactive Technology Help Us to Experience Joy With(in) the Forest? Towards a Taxonomy of Tech for Joyful Human-Forest Interactions. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–21. https://doi.org/10.1145/3706598.3713151

[4] Riga Anggarendra and Margot Brereton. 2016. Engaging children with nature through environmental HCI. In *Proceedings of the 28th Australian Conference on Computer-Human Interaction - OzCHI '16*. ACM Press, Launceston, Tasmania, Australia, 310–315. https://doi.org/10.1145/3010915.3010981

[5] Angelina Aspra Aquino, Ian Mongunu Gumbula, Nicola Bidwell, and Steven Bird. 2024. What's the weather story? both-ways learning in Indigenous-led climate communication workshops in northern Australia. In *Proceedings of the Participatory Design Conference 2024: Exploratory Papers and Workshops-Volume 2*. 166–174.

[6] Fredrik Aspling, Jinyi Wang, and Oskar Juhlin. 2016. Plant-computer interaction, beauty and dissemination. In *Proceedings of the Third International Conference on Animal-Computer Interaction*. ACM, Milton Keynes United Kingdom, 1–10. https://doi.org/10.1145/2995257.2995393

[7] Isabella Bain and Martin Tomitsch. 2022. Designing for Personas That Don't Have a Voice: Reflections on Designing a Mobile Application for Collecting Biodiversity Data. In *Proceedings of the 34th Australian Conference on Human-Computer Interaction*. ACM, Canberra ACT Australia, 229–234. https://doi.org/10.1145/3572921.3572945

[8] Fiona Bell, Joshua Coffie, and Mirela Alistar. 2024. Bio-Digital Calendar: Attuning to Nonhuman Temporalities for Multispecies Understanding. In *Proceedings of the Eighteenth International Conference on Tangible, Embedded, and Embodied Interaction*. ACM, Cork Ireland, 1–15. https://doi.org/10.1145/3623509.3633386

[9] Nicola J Bidwell. 2020. Wireless in the weather-world and community networks made to last. In *Proceedings of the 16th Participatory Design Conference 2020-Participation (s) Otherwise-Volume 1*. 126–136.

[10] Nicola J Bidwell and David Browning. 2006. Making there: methods to uncover egocentric experience in a dialogic of natural places. In *Proceedings of the 18th Australia conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments*. 229–236.

[11] Nicola J. Bidwell and David Browning. 2010. Pursuing genius loci: interaction design and natural places. *Personal and Ubiquitous Computing* 14, 1 (Jan. 2010), 15–30. https://doi.org/10.1007/s00779-009-0217-8

[12] Nicola J Bidwell, Chris Elsden, Ludwig Trotter, Josh Hallwright, Sadie Moore, Kate Jeite-Delbridge, Mike Harding, Peter Shaw, Nigel Davies, Chris Speed, et al. 2021. A right time to give: Beyond saving time in automated conditional donations. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. 1–20.

[13] Nicola J Bidwell, Peta-Marie Standley, Tommy George, and Vicus Steffensen. 2008. The landscape's apprentice: lessons for place-centred design from grounding documentary. In *Proceedings of the 7th ACM conference on Designing interactive systems*. 88–98.

[14] Nicola J Bidwell and Heike Winschiers-Theophilus. 2012. Audio pacemaker: walking, talking indigenous knowledge. In *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference*. 149–158.

[15] Bidwell, N. J., Reitmaier, T., Rey-Moreno, C., Roro, Z., Siya, M., and Dlutu-Siya, B. 2013. Timely Relations in Rural Africa. In *Proc. 12th International Conference on Social Implications of Computers in Developing Countries Jamaica*. The International Federation for Information Processing (IFIP), Jamaica, WG 9.4: 92–106.

[16] Roberto Cibin, Sarah Robinson, Nicola J. Bidwell, Conor Linehan, Laura Maye, Nadia Pantidi, and Maurizio Teli. 2021. Land, Water and Sun: Tuning into Socio-Ecological Relations in Radio Design. In *Designing Interactive Systems Conference 2021*. ACM, Virtual Event USA, 1954–1969. https://doi.org/10.1145/3461778.3462104

[17] Bawaka Country, Sarah Wright, Sandie Suchet-Pearson, Kate Lloyd, Laklak Burarrwanga, Ritjilili Ganambarr, Merrkiyawuy Ganambarr-Stubbs, Banbapuy Ganambarr, and Djawundil Maymuru. 2015. Working with and learning from Country: decentring human author-ity. *cultural geographies* 22, 2 (April 2015), 269–283. https://doi.org/10.1177/1474474014539248

[18] B. Cumbo and R. Potts. [n. d.]. Our Water Stories: A participatory film method to support children set the agenda for design.. In *Proceedings of 18th Participatory Design Conference (PDC '24)*. Sibu, Sarawak, Malaysia. https://doi.org/10.1145/3666094.3666100

[19] Bronwyn J. Cumbo, Eva Eriksson, and Ole Sejer Iversen. 2019. The "Least-Adult" Role in Participatory Design with Children. In *Proceedings of the 31st Australian Conference on Human-Computer-Interaction*. ACM, Fremantle WA Australia, 73–84. https://doi.org/10.1145/3369457.3369464

[20] Bronwyn J. Cumbo and Ole Sejer Iversen. 2020. CCI in the wild: designing for environmental stewardship through children's nature-play. In *Proceedings of the Interaction Design and Children Conference*. ACM, London United Kingdom, 335–348. https://doi.org/10.1145/3392063.3394398

[21] Marketa Dolejsova, Jaz Hee-jeong Choi, Andrea Botero, and Cristina Ampatzidou. 2022. Open forest: Data, stories, and walking-with. In *Proceedings of the Participatory Design Conference 2022-Volume 2*. 309–312.

[22] Rachael C. Edwards and Brendon M. H. Larson. 2020. When screens replace backyards: strategies to connect digital-media-oriented young people to nature. *Environmental Education Research* 26, 7 (July 2020), 950–968. https://doi.org/10.1080/13504622.2020.1776844

[23] Pedro Galvão-Ferreira, Marta Galvão Ferreira, Teresa Maritza Gouveia Da Silva, Nuno Jardim Nunes, and Valentina Nisi. 2025. The Entangled Tales that Landscapes Tell: An Embodied HCI Pedagogy for Re-enchanted Nature Walks. In *Proceedings of the Nineteenth International Conference on Tangible, Embedded, and Embodied Interaction*. ACM, Bordeaux/Talence France, 1–13. https://doi.org/10.1145/3689050.3705012

[24] William Gaver, Andy Boucher, Michail Vanis, Andy Sheen, Dean Brown, Liliana Ovalle, Naho Matsuda, Amina Abbas-Nazari, and Robert Phillips. 2019. My Naturewatch Camera: Disseminating Practice Research with a Cheap and Easy DIY Design. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, Glasgow Scotland Uk, 1–13. https://doi.org/10.1145/3290605.3300532

[25] Elisa Giaccardi, Johan Redström, and Iohanna Nicenboim. 2024. The making(s) of more-than-human design: introduction to the special issue on more-than-human design and HCI. *Human–Computer Interaction* (May 2024), 1–16. https://doi.org/10.1080/07370024.2024.2353357

[26] Sara Heitlinger, Marcus Foth, and Rachel Clarke (Eds.). 2024. *Designing More-than-Human Smart Cities: Beyond Sustainability, Towards Cohabitation* (1 ed.). Oxford University PressOxford. https://doi.org/10.1093/oso/9780191980060.001.0001

[27] Jonna Häkkilä, Nicola J. Bidwell, Keith Cheverst, Ashley Colley, Felix Kosmalla, Simon Robinson, and Johannes Schöning. 2018. Reflections on the NatureCHI Workshop Series: Unobtrusive User Experiences with Technology in Nature. *International Journal of Mobile Human Computer Interaction* 10, 3 (July 2018), 1–9. https://doi.org/10.4018/IJMHCI.2018070101

[28] Thomas Kenote. 2020. Indigenous Phenology: An Interdisciplinary Case Study on Indigenous Phenological Knowledge on the Menominee Nation Forest. (June 2020). https://hdl.handle.net/11299/216076

[29] Madlen Kneile, Judith Dörrenbächer, Marc Hassenzahl, and Matthias Laschke. 2025. Mediating Human-Nature Relations Through Technology. A Scoping Review of Post-Anthropocentric Artifacts and Their Design Strategies. *ACM Transactions on Computer-Human Interaction* (2025).

[30] Louise Chawla. 2007. Childhood Experiences Associated with Care for the Natural World: A Theoretical Framework for Empirical Results. *Children, Youth and Environments* 17, 4 (2007), 144–170. http://www.jstor.org/stable/10.7721/chilyoutenvi.17.4.0144 Publisher: University of Cincinnati.

[31] Beatrice Maggipinto, Nuno Jardim Nunes, Jessica Hammer, Yanick Trindade, and Valentina Nisi. 2025. Diving into the Abyss: Exploring Deep Sea Connection and Curiosity through Virtual Reality. In *Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–18. https://doi.org/10.1145/3706598.3713833

[32] Clara Mancini. 2023. Responsible ACI: Expanding the Influence of Animal-Computer Interaction. In *The Tenth International Conference on Animal-Computer Interaction*. ACM, Raleigh NC USA, 1–9. https://doi.org/10.1145/3637882.3637895

[33] Victor Benno Meyer-Rochow. 2009. Food taboos: their origins and purposes. *Journal of ethnobiology and ethnomedicine* 5, 1 (2009), 18.

[34] Gladys Milroy and Jill Milroy. 2008. Different ways of knowing: Trees are our families too. In *Heartsick for country: Stories of love, spirit and creation*. Fremantle Press, 22–42.

[35] Iohanna Nicenboim, Doenja Oogjes, Heidi Biggs, and Seowoo Nam. 2025. Decentering Through Design: Bridging Posthuman Theory with More-than-Human Design Practices. *Human–Computer Interaction* 40, 1-4 (July 2025), 195–220. https://doi.org/10.1080/07370024.2023.2283535 Publisher: Informa UK Limited.

[36] T. Noorani and Brigstocke, J. 2018. *More-than-human Participatory Research*. University of Bristol and the AHRC Connected Communities Programme.

[37] Piumi Perera, Shannon Rodgers, Nicola J. Bidwell, Sarah Webber, Kellie Vella, Huiwen Zhang, and Bronwyn Cumbo. 2024. Engaging with Nature in a Digital World. In *Proceedings of the 36th Australasian Conference on Human-Computer Interaction*. ACM, Meanjin | Brisbane Australia, 853–859. https://doi.org/10.1145/3726986.3727935

[38] Piumi Perera, Sarah Webber, and Wally Smith. 2024. Digital design considerations in urban nature. In *Proceedings of the 27th International Academic Mindtrek Conference*. ACM, Tampere Finland, 235–243. https://doi.org/10.1145/3681716.3689441

[39] Shannon Rodgers, Bernd Ploderer, Kellie Vella, and Margot Brereton. 2024. Phenology Circles: A Method to Deepen Relations in More-Than-Human Design Processes. In *Designing Interactive Systems Conference*. ACM, IT University of Copenhagen Denmark, 1059–1073. https://doi.org/10.1145/3643834.3660694

[40] Y. Rogers, S. Price, G. Fitzpatrick, R. Fleck, E. Harris, H. Smith, C. Randell, H. Muller, C. O'Malley, D. Stanton, M. Thompson, and M. Weal. 2004. Ambient wood: designing new forms of digital augmentation for learning outdoors. In *Proceedings of the 2004 conference on Interaction design and children: building a community*. ACM, Maryland, 3–10. https://doi.org/10.1145/1017833.1017834

[41] Alessandro Soro, Margot Brereton, Tshering Dema, Jessica L. Oliver, Min Zhen Chai, and Aloha May Hufana Ambe. 2018. The Ambient Birdhouse: An IoT Device to Discover Birds and Engage with Nature. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. ACM, Montreal QC Canada, 1–13. https://doi.org/10.1145/3173574.3173971

[42] Velvet Spors, Oğuz 'Oz' Buruk, and Juho Hamari. 2025. Human-Nature Relationships through Video Games: An Exploration of Players' Sense-Making. In

Proceedings of the 2025 CHI Conference on Human Factors in Computing Systems. ACM, Yokohama Japan, 1–17. https://doi.org/10.1145/3706598.3713207

[43] Velvet Spors, Samuli Laato, Oğuz 'Oz' Buruk, and Juho Hamari. 2023. Longing to be the Mountain: A Scoping Review about Nature-Centric, Health-Minded Technologies. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–16. https://doi.org/10.1145/3544548.3581479

[44] Peta-Marie Standley, Nicola J Bidwell, Tommy George Senior, Victor Steffensen, and Jacqueline Gothe. 2009. Connecting Communities and the Environment through Media: Doing, Saying and Seeing Along Traditional Knowledge Revival Pathways. 5 (2009).

[45] Jennyfer Lawrence Taylor, Alessandro Soro, Paul Roe, Anita Lee Hong, and Margot Brereton. 2017. Situational When: Designing for Time Across Cultures. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, Denver Colorado USA, 6461–6474. https://doi.org/10.1145/3025453.3025936

[46] Bill Tomlinson, Bonnie Nardi, Daniel Stokols, and Ankita Raturi. 2021. Ecosystemas: Representing Ecosystem Impacts in Design. In *Extended Abstracts of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–10. https://doi.org/10.1145/3411763.3450382

[47] Masatsugu Toyota, Dirk Spencer, Satoe Sawai-Toyota, Wang Jiaqi, Tong Zhang, Abraham J. Koo, Gregg A. Howe, and Simon Gilroy. 2018. Glutamate triggers long-distance, calcium-based plant defense signaling. *Science* 361, 6407 (2018), 1112–1115. https://doi.org/10.1126/science.aat7744 _eprint: https://www.science.org/doi/pdf/10.1126/science.aat7744.

[48] Lauren Tynan. 2021. What is relationality? Indigenous knowledges, practices and responsibilities with kin. *cultural geographies* 28, 4 (Oct. 2021), 597–610. https://doi.org/10.1177/14744740211029287

[49] Lily M. Van Eeden, Lachlan Francis, Zoe E. Squires, Fern Hames, Sarah A. Bekessy, Liam Smith, and Melissa Hatty. 2023. Demographic and spatial variables associated with spending time in nature during COVID-19 lockdowns. *Urban Forestry & Urban Greening* 82 (April 2023), 127895. https://doi.org/10.1016/j.ufug.2023.127895

[50] Asimina Vasalou and Andrea Gauthier. 2023. The role of CCI in supporting children's engagement with environmental sustainability at a time of climate crisis. *International Journal of Child-Computer Interaction* 38 (Dec. 2023), 100605. https://doi.org/10.1016/j.ijcci.2023.100605

[51] Jake Stuart Veasey. 2019. Assessing the Psychological Priorities for Optimising Captive Asian Elephant (Elephas maximus) Welfare. *Animals* 10, 1 (Dec. 2019), 39. https://doi.org/10.3390/ani10010039 Publisher: MDPI AG.

[52] Kellie Vella, Bernd Ploderer, and Margot Brereton. 2021. Human-Nature Relations in Urban Gardens: Explorations with Camera Traps. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems*. ACM, Yokohama Japan, 1–13. https://doi.org/10.1145/3411764.3445438

[53] Filip Vostal. 2015. Academic life in the fast lane: The experience of time and speed in British academia. *Time & Society* 24, 1 (March 2015), 71–95. https://doi.org/10.1177/0961463X13517537

[54] Sarah Webber, Marcus Carter, Wally Smith, and Frank Vetere. 2020. Co-Designing with Orangutans: Enhancing the Design of Enrichment for Animals. In *Proceedings of the 2020 ACM Designing Interactive Systems Conference*. ACM, Eindhoven Netherlands, 1713–1725. https://doi.org/10.1145/3357236.3395559

[55] Sarah Webber, Mia L. Cobb, and Jon Coe. 2022. Welfare Through Competence: A Framework for Animal-Centric Technology Design. *Frontiers in Veterinary Science* 9 (June 2022). https://doi.org/10.3389/fvets.2022.885973 Publisher: Frontiers Media SA.

[56] Sarah Webber, Ryan M. Kelly, Greg Wadley, and Wally Smith. 2023. Engaging with Nature through Technology: A Scoping Review of HCI Research. In *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*. ACM, Hamburg Germany, 1–18. https://doi.org/10.1145/3544548.3581534

[57] Anna Zamansky, Amanda Roshier, Clara Mancini, Emily C. Collins, Carol Hall, Katie Grillaert, Ann Morrison, Steve North, and Hanna Wirman. 2017. A Report on the First International Workshop on Research Methods in Animal-Computer Interaction. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, Denver Colorado USA, 806–815. https://doi.org/10.1145/3027063.3052759

A Workshop Worksheet

Each participant was provided with a copy of the following worksheet to use during their exploration of nature around the conference venue. The instructions listed are as follows:

Walk through the UQ Lakes precinct with your group. you might focus on a specific area or explore a range of sites.

- Reflect on opportunities for technology to support human-nature relations.

- Collate multiple ideas, to discuss and refine after the tour.
- Collect data to support your thinking: photos, videos, field notes, sketches, voice memos etc.

Think about the following questions during this exercise:

(1) What new or interesting role could technology adopt to support human-nature relations at UQ Lakes?

(2) What are some qualities of human-nature relations you are focusing on?

(3) Which people, other species, or natural phenomena do you imagine will use your technology?

(4) How do you imagine technology being used in this context, and how will it support the qualities of relations, interactions, or connections?

(5) What existing challenges related to technology and UQ Lakes could your idea address?

(6) What are some potential downsides or possible consequences of your technology?