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RESEARCH

Eco-cultural monitoring reveals low impact of a Dharug *Dhiyina* women-led *Guwiyang* (fire) in an urban National Park, Australia

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Abstract

Indigenous-led fire stewardship is increasingly recognised as important for ecological and cultural resilience; however, it remains rare in urban landscapes due to regulatory barriers, colonial fear of fire and risk aversion. This study aligned with the first Dharug *dhiyina* women-led *guwiyang* (fire) at *Bidyiwung Badhu Nuru* (Brown's Waterhole, Lane Cove National Park) since European invasion of what is now called Sydney, some 230 years ago. Using a collaborative ecological and cultural (eco-cultural) monitoring approach, we evaluated Dharug *dhiyina*-defined ecological parameters before and after the *guwiyang* and at three control sites using a modified Before-After-Control-Impact ecological assessment. At each site, we monitored changes in fuel load, soil properties, culturally significant plants and mammal activities. The low-intensity, patchy *guwiyan*g had a low flame height, a slow rate of spread, and significantly reduced fuel loads (surface and low-to-mid-storey). Following the *guwiyang*, we observed basal resprouting of the culturally significant edible and medicinal plant *Dybung/Mambara* (narrow-leaved geebung, *Persoonia linearis*). Consistent with Dharug *dhiyina* objectives, the low-intensity *guwiyang* reduced the short-term dominance of *Daynya* (common hop bush, *Dodonaea triquetra*) and *Gurgi* (bracken fern, *Pteridium esculentum*; soft bracken, *Calochlaena dubia*). *Daynya* showed minimal resprouting or germination, and *Gurgi* cover declined with low frond emergence after three months. After the *guwiyang*, we detected no change in soil properties or activity of *Burraga* (long-nosed bandicoot, *Perameles nasuta*) or *Bagarayi* (swamp wallaby, *Wallabia bicolor*). This study provided a rare analysis of the ecological outcomes of cultural burning in an urban bushland environment. Furthermore, we offer replicable methods for the cross-cultural collaborative design of monitoring approaches that can simultaneously serve eco-cultural goals.

Keywords Indigenous fire management · Gendered conservation · Urban-bushland interface · First Nations conservation · Biocultural conservation · Co-design

Positionality statement This project was initiated by Dharug *dhiyina* (JR) and undertaken with other Dharug women, allies, as well as non-Indigenous Australian early and mid-career researchers (GB, EE and MC) affiliated with Macquarie University, which is adjacent to the Lane Cove National Park in northern Sydney where the research was undertaken. The authors listened and learnt from Dharug *Ngurra* (Country) as the senior author of this research. The site where the research was undertaken holds cultural significance and ancestral connection for the co-author JR (Fig. 1, Rey 2021). The research drew on expertise from the biological sciences (GB, EE, HC) and Indigenous research (JR), informed by existing strong cross-cultural collaborative research partnerships with Dharug (JR) and other Indigenous groups across Australia (EE, GB). This research aimed to raise awareness of and gather evidence for the potential eco-cultural outcomes (positive, neutral, and negative) of the contemporary resurgence of Indigenous fire practices in highly urbanised and government-controlled bushland.

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Introduction

Indigenous urban fire management

Following centuries of the pervasive global to local impacts of European imperialism and colonisation, Indigenous groups worldwide are increasingly reinstating traditional or cultural conservation practices, including through the use of fire (Ngurra et al. 2019; Fletcher et al. 2021; Hoffman et al. 2022; Díaz et al. 2023; Maclean et al. 2023; Rey et al. 2025). However, in contemporary settings, particularly in densely populated urban areas, significant barriers remain. Fire management is highly regulated to protect infrastructure and assets, and prevent large, destructive wildfires (Smith et al. 2021; Williamson 2022; McCormack et al. 2024). Within urban-bushland interfaces, where native remnant bushland is situated adjacent to densely populated areas, the perceived threat and potential danger of fire is amplified (Bradstock et al. 1998; Darques 2015; Bento-Gonçalves and Vieira 2020). This has contributed to entrenched risk aversion in urban fire and vegetation management decision-making. In colonised nations such as Australia, Canada, and the United States of America, such caution is further shaped by colonial-era fear of fire and the systematic exclusion and suppression of Indigenous peoples and traditional land stewardship practices (Lake and Christianson 2020; Freeman et al. 2021; Smith et al. 2021; Hoffman et al. 2022; McCormack et al. 2024). Indigenous scholars and allies emphasise the ecological and cultural (eco-cultural) benefits of decolonising fire 'management' policies in contemporary settings and revitalising nuanced Indigenous fire practices and knowledges that have evolved with changing climates and changing landscapes, for millennia (Bowman and Panton 1995; Howitt and Suchet-Pearson 2006; Russell-Smith et al. 2013; Neale et al. 2019; Pascoe et al. 2023).

Across many parts of the world, Indigenous use of fire reflects broader responsibilities of cultural stewardship, including caring for Country as kin (Tynan 2020), sustaining resources (Bliege Bird et al. 2008; Jones 2012), and facilitating access to Country and cultural sites (Lake and Christianson 2020; Fletcher et al. 2021; Tynan (2021); Ngurra et al. 2025). In remote areas, many Indigenous groups have been able to maintain and/or revitalise traditional fire practices to a greater extent than in urban landscapes, where land access, legal recognition, and structural barriers have limited such opportunities (Williamson and Weir 2021; Hoffman et al. 2022; Williamson 2022). In Australia, this is evident in central and northern regions, where many Indigenous communities have been able to maintain strong access to ancestral lands and practice customary fire traditions (Russell-Smith et al. 1997; Ansell and Evans 2019; Williamson 2022; McCormack et al. 2024). Research within these regions highlights the ecological, cultural, social, and economic benefits of maintaining traditional fire 'management' practices in contemporary settings (see Vigilante and Bowman 2004; Russell-Smith et al. 2009; Bird et al. 2018; Legge et al. 2024). By contrast, south-eastern Australian Indigenous communities face greater barriers to traditional fire management practices due to the dominance of European farming and contemporary urban influences.

However, despite these constraints, Indigenous fire knowledge persists within urban and regional area and is being actively revitalised, albeit on a smaller scale (Steffensen 2020; Freeman et al. 2021; Cavanagh 2022; Pascoe et al. 2023; Rey et al. 2025). Some of this activity has been documented in the academic literature (e.g., McKemey et al. 2019; Neale et al. 2019; Ngurra et al. 2019; Freeman et al. 2021; Cavanagh 2022; Atkinson and Montiel-Molina 2023; Weir 2023; Bowd et al. 2025; Rey et al. 2025), although there is a paucity of quantitative ecological research on cultural burning outcomes that is of interest to evidence-based fire policy decision-makers (McKemey et al. 2020). It is also important to acknowledge that many burns conducted by Indigenous Peoples are not documented in mainstream, publicly accessible platforms.

Indigenous women led conservation

Additionally, there is a growing movement to reinstate Indigenous women's roles in cultural burning, reflecting long-standing gendered responsibilities and ecological knowledge (Bird et al. 2004; Tynan and Cavanagh 2021; Cavanagh 2022; Rey et al. 2025). Researchers have noted the lack of recognition of women's involvement in natural resource management more broadly (Sithole et al. 2008; James et al. 2021). Despite evidence that women's governance is central within kinship-based systems of Law and responsibility (Dudgeon and Bray 2019), Indigenous women remain under-represented in conservation leadership—a critical gap given their gender-specific cultural responsibilities and knowledge (Cavanagh 2022). Notable exceptions highlight women's leadership in cultural fire practice (e.g. Bird et al. 2004; Tynan (2021); Cavanagh 2022; Rey et al. 2025). This is likely a reflection of imposed European colonial and patriarchal processes, reinforced by male-dominated research that often failed to record or acknowledge the role of Indigenous women (Cavanagh 2022). This project aimed to address the research gap on the quantitative ecological outcomes of Indigenous women-led cultural burning, using a cross-cultural approach that prioritised Indigenous values in the requested Western scientific research. The present quantitative research complements the qualitative Indigenous-led research of the socio-cultural outcomes of the Dharug *dhiyina*-led burn (Rey et al. 2025).

Benefits of cross-cultural monitoring

Similar to the process of burning itself, ecological monitoring can also be decolonised to reflect and highlight Indigenous values, knowledge systems, and approaches to caring for Country (Ens et al. 2012; Cooke et al. 2022; Ens and Turpin 2022). Moreover, research indicates that increased collaboration between Indigenous Peoples and Western-trained scientists can deliver enhanced cross-cultural learning and conservation outcomes (Ens et al. 2015; Eloy et al. 2019; Bourke et al. 2020; Fletcher et al. 2021). Effective monitoring and communication of cross-cultural conservation outcomes can enhance understanding and foster broader receptiveness and support (Robinson et al. 2018; Ansell and Evans 2019), particularly in urban landscapes where Indigenous practices have been significantly disrupted or suppressed (David et al. 2024). Although cultural burning remains rare in urban settings, Australian (McKemey et al. 2022; Bowd et al. 2025; Ngurra et al. 2025) and international examples (Christianson 2014; Nikolakis and Ross 2022) demonstrate how cross-cultural partnerships and effective monitoring can promote ecological, cultural, and social outcomes and abate the fear associated with fire. Some examples in Australia include Dja Dja Wurrung and bushfire agency "decolonising experiments" in Victoria (Neale et al. 2019); Banbai and scientist monitoring where low-intensity cultural burns had low impact on short-beaked echidna *(Tachyglossus aculeatus)* relative to adjacent prescribed burns (McKemey et al. 2019); and positive soil responses to Indigenous-led burning on the south-east coast (Country et al. 2024). Similar benefits are reported internationally (Christianson 2014; Nikolakis and Ross 2022; Dickson-Hoyle et al. 2024). However, we found no examples in urban ecosystems.

Exploring cultural guwiyang (fire) in the global city of Sydney

Despite the growth of Indigenous cultural burning in remote and regional contexts, there has been limited research in urban landscapes, including south-eastern Australia (Neale et al. 2019; Pascoe et al. 2023; Rawluk et al. 2023). Novel approaches to urban biodiversity management are crucial, as these areas face disproportionately high species loss due to habitat fragmentation, invasive species, altered fire regimes, and urban encroachment (Fitzgibbon et al. 2011; Kirkpatrick et al. 2023). In the fragmented environments of Sydney, Australia, conservation of small, ground-dwelling animals such as the long-nosed bandicoot (*Perameles nasuta*), in part, require habitat mosaics including dense refuges and open foraging areas, conditions that were likely historically sustained through fire (Scott et al. 1999). Southern brown bandicoots (*Isoodon obesulus*) have also persisted in human-modified landscapes and shown to benefit from repeated low-intensity burns, although foraging was found to initially decline after fire (Maclagan et al. 2018; Kirkpatrick et al. 2023). Such studies indicate the complex interplay between fire frequency, habitat condition and urban pressures, reinforcing the need to consider cultural burning as a nuanced fire management strategy in fragmented urban-bushland interfaces.

In the Sydney Basin, early European colonial records and palaeoecological studies note that before European colonisation, Dharug Traditional Custodians and neighbouring groups used fire to manage their ancestral clan estates (Clark and McLoughlin 1986; Kohen 1986; McLoughlin 1998; Black and Mooney 2007; Gammage 2012; Jurskis and Underwood 2013). Following European colonisation, cultural fire practices were widely suppressed across south-eastern Australia (Cahir et al. 2018; McCormack et al. 2024), including within the Sydney Basin, where burning largely ceased (Attenbrow 2010). This was due to the dispossession of local Indigenous groups and disruption of cultural practices directly through force, coercion, death and detainment, and indirectly, such as through introduced diseases (Brook and Kohen 1991; Karskens 2009; Poulter 2016). Despite these significant impacts on Sydney's Traditional Custodians and their cultural responsibilities, Dharug have continued cultural practices across *Ngurra* (Country), where they could and still can. Recently, there has been an increasing re-ignition of and advocacy for Dharug *guwiyang* (fire) as a deliberate act of restorative healing for *Ngurra* and the community (Ngurra et al. 2019; Rey et al. 2025).

The present study supported the revitalisation of Indigenous cultural burning at *Bidyiwung Badhu Nuru* (Brown's Waterhole), Walumadagal *Ngurra*, near Macquarie University, northern Sydney, where Dharug *guwiyang* and associated research had not occurred since European colonisation some 230 years prior (Rey et al. 2025). A cross-cultural collaboration was cultivated between Dharug *dhiyina* (women) and university scientists to explore the eco-cultural responses of 'other-than-human' (biophysical) landscape elements to a low-intensity Dharug *dhiyina guwiyang* (see Appendix 1 for glossary of Dharug terms). Through a series of co-developed eco-cultural research processes between Dharug *dhiyina* and author JR, the Dharug Women's and Allies Cultural Fire Alliance (DWACFA) and non-Indigenous researchers GB, EE and HC, the following key objectives for the research were identified: (1) Create a low intensity fire that reduced fuel loads for wildfire mitigation; (2) Understand the fire response of culturally significant plant species, such as *Dybung/Mambara* (narrow-leaved geebung, *Persoonia linearis*), and reduce the dominance of *Daynya* (common hop bush, *Dodonaea triquetra*) and *Gurgi* (bracken fern, *Pteridium esculentum*; soft bracken, *Calochlaena dubia*); (3) Understand how soil properties respond to the *guwiyang*; and (4) Understand how culturally important mammal species *Burraga* (long-nosed bandicoot, *Perameles nasuta*) and *Bagarayi* (swamp wallaby, *Wallabia bicolor*) responded to the *guwiyang*.

Methods

Co-developing the eco-cultural approach

Our work was guided by 'Goanna Walking'—a Dharug-described approach for moving between Aboriginal and Western ways, with careful yarning, listening and observations, taking "left" and "right" steps across the intercultural interface, to leave a shared "tail/tale" in the middle that brings people together on Ngurra (Rey and Harrison 2018). The process was organic and non-linear, characterised by deliberate connections and opportunistic consultations/yarns between the non-Indigenous researchers and Dharug *dhiyina* (women) (responsive to availability) to collectively shape the research (Fig. 1; Rey et al. 2025).

The objectives for the *guwiyang* had already been identified prior to engagement of the non-Indigenous researchers, through enduring Dharug relationality and weaving connections with key stakeholders at the Stakeholder Days (2022)—meetings that facilitated planning and opening channels for communication and relationship building—and cultural workshops on Ngurra (Fig. 1; Rey et al. 2025). In preparation of the *guwiyang*, the Dharug *dhiyina* had conducted exploratory biocultural monitoring of edible, medicinal and useful plants using CyberTracker (Liebenberg 2012), and animal activity using three camera traps (Fig. 1; Rey et al. 2025). Noting the complexity of the system and to include the interests of non-Indigenous scientists, in 2023, the Dharug Women's and Allies Cultural Fire Alliance (DWACFA), which included Dharug *dhiyina* as members, collaborated with non-Indigenous researchers (GB, EE, HC) to expand the eco-cultural monitoring of 'other-than-human' responses to the proposed Dharug *dhiyina guwiyang*. The ecological monitoring (Fig. 1) was intended to complement the socio-cultural research led by JR (Rey 2022; Rey et al. 2025) as well as other cultural burns led by other Dharug people in different parts of Dharug *Ngurra* in western Sydney (Ngurra et al. 2019, 2025).

To identify Dharug interests and focus the monitoring parameters, following Bessarab and Ng'Andu (2010) and Cooke et al. (2022), we undertook Yarning sessions (August/September 2023; Fig. 1) which began with informal social and collaborative yarns between JR, EE and GB, with JR as the key liaison between Dharug *dhiyina*, DWACFA and Macquarie University. Through this process we built relationships, trust and ideas for the parameters that would serve the aspirations of the Dharug *dhiyina*.

In early September 2023, EE and GB were invited to join the Dharug *dhiyina* on Ngurra at *Bidyiwung Badhu Nuru* (the planned *guwiyang* site), where *dhiyina* were checking site conditions and discussing burn plans. This visit allowed GB to meet the *dhiyina*, listen to and learn about their plans and desired outcomes for the *guwiyang*, and ask about biocultural values at the site (e.g., culturally significant plants and animals). Building on these conversations, JR, EE and GB held follow-up topic-focused yarns that drew on priorities previously identified by JR and the Dharug *dhiyina*, including at the 2022 Stakeholder Days (Fig. 1). Through this process, we identified specific Dharug interests and aspirations for 'other-than-human' responses to the proposed *guwiyang*, such as soil properties and culturally significant animals and plants, that formed the study objectives and measures (Fig. 1). The *dhiyina* were interested in reducing the dominance of *Daynya* (common hopbush, *Dodonaea* triquetra) and *Gurgi* (bracken fern, *Pteridium esculentum*; soft bracken). Although they are medicinal and edible plants, respectively, they were considered too abundant and smothering other native ground cover species. The Dharug *dhiyina* were also interested in monitoring the *guwiyang* response of medicinal and edible *Dybung/Mambara* (narrow-leaved geebung, *Persoonia linearis*).

The *Dhiyina*-defined measures were combined with parameters suggested by non-Indigenous researchers (e.g., scorch height, fuel load) and a robust ecological design (Before–After–Control–Impact) was suggested to strengthen inferences about the *guwiyang* outcomes. The proposed eco-cultural monitoring plan was shared with Dharug *dhiyina* via email for input, feedback and endorsement. It was further discussed with Dharug *dhiyina* and DWACFA during Dharug decision-making processes for the *guwiyang*, including a Stakeholder Day (February 2024) and pre-burn cultural workshop (March 2024; Fig. 1).

Impact and control study site descriptions

The Dharug *dhiyina guwiyang* was undertaken in April 2024 at *Bidyiwung Badhu Nuru* (Fig. 1), Lane Cove National Park (LCNP), in north-west Sydney, Australia (Fig. 2). LCNP is an important urban habitat refuge for threatened flora and fauna (Reidy et al. 2005) within an urban residential and light commercial zone adjacent to Macquarie University (Office of Environment and Heritage 2016). The planned *guwiyang* area (30mx30m) was relatively small, as Dharug *dhiyina* wanted to tread slowly to build the teams confidence, avoid instilling fear, and reduce the dominance of *Daynya* and *Gurgi*.

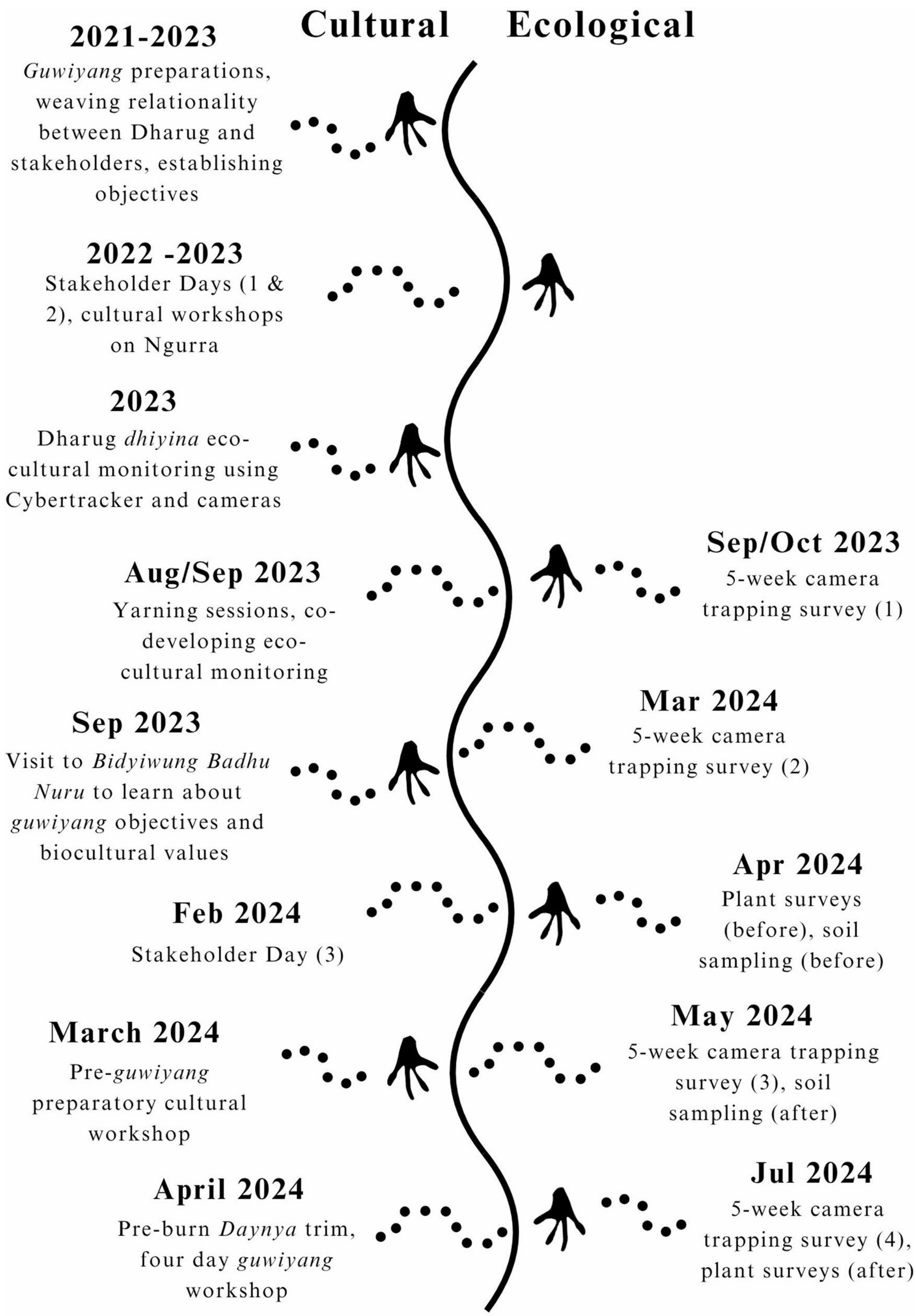

Fig. 1 'Goanna Walking' project timeline illustrating the process of eco-cultural monitoring underpinning the study—Aboriginal relationality to the left and Western ecological approaches to the right (Rey and Harrison 2018)

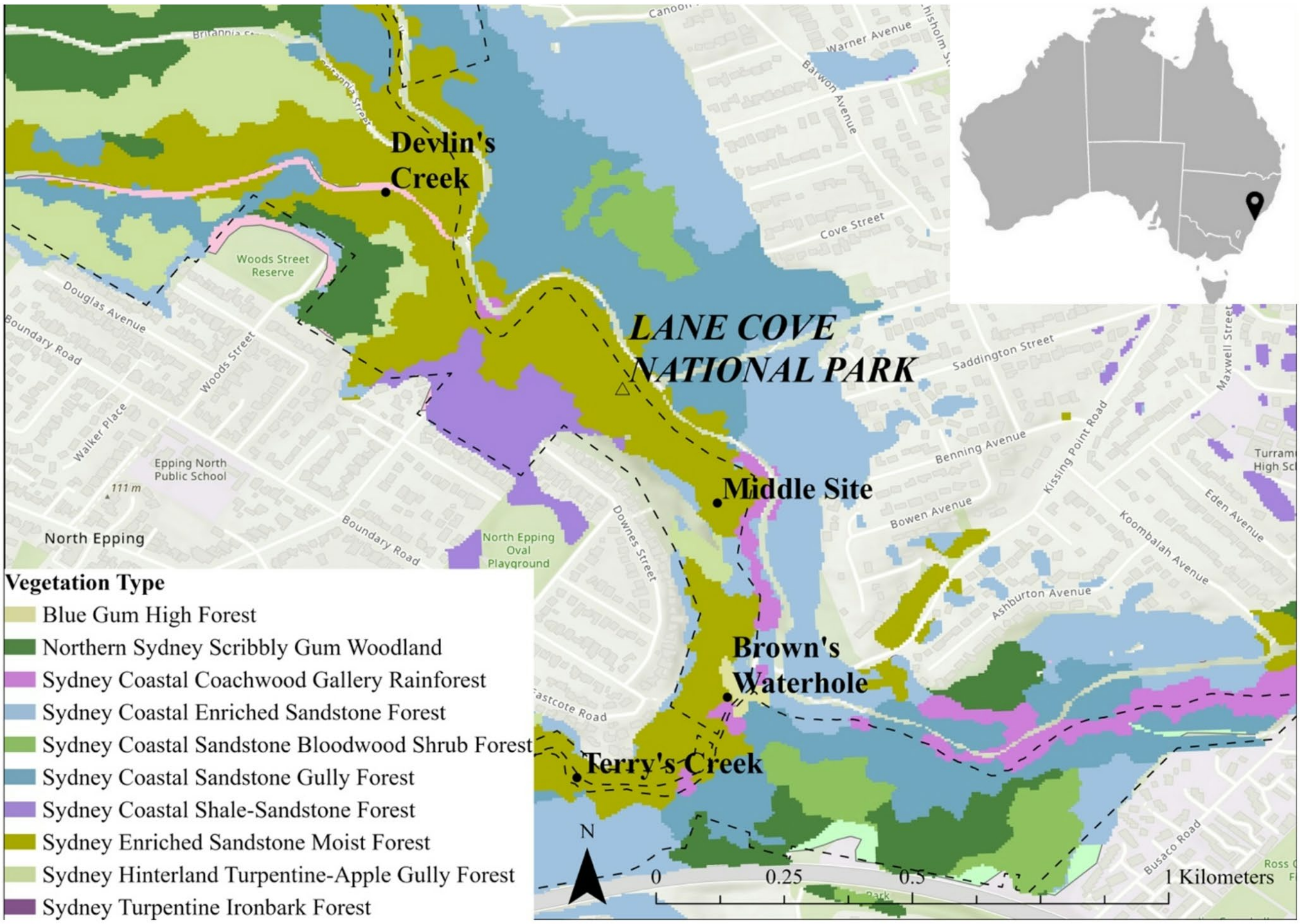

Fig. 2 Vegetation map of the impact (*Bidyiwung Badhu Nuru*/Brown's Waterhole) and control (Devlin's Creek, Middle Site, Terry's Creek) sites in Lane Cove National Park (dashed line), northern Sydney, Australia

We compared 'other-than-human' responses to the *Bidyiwung Badhu Nuru guwiyang* (impact site) with three adjacent control sites, following the modified BACI (Before-After, Control-Impact) monitoring design of Underwood (1994) that compared parameters at a single impact site with multiple (three) control sites (Pardini et al. 2018). We used multiple criteria to identify suitable control areas: within 2 km of the burn site in LCNP; 300–900 m apart; and similar vegetation type, aspect, slope, elevation, and proximity to the Lane Cove River (~20 m) (Fig. 2). A haphazard site selection process was used to identify three specific sites within suitable control areas. The vegetation of the study was Sydney Enriched Sandstone Moist Forest (sclerophyll) (Fig. 1; DCCEEW 2020). The soil was classified as rudosol, with well-drained sand and gravel composition (Department of Planning 2021). Dominant and culturally significant tree species at the sites included: Sydney peppermint (*Eucalyptus piperita*), red bloodwood (*Corymbia gummifera*), Sydney red gum (*Angophora costata*) and blackbutt (*Eucalyptus pilularis*). Mid-story species included: *Dybung/Mambara* (broad-leaved geebung, *Persoonia levis;* narrow-leaved geebung, *Persoonia linearis*), linear-leaf grevillea (*Grevillea linerifolia*), blueberry ash (*Elaeocarpus reticulatus*) and *Gulgadya* (broadleaf grass tree, *Xanthorrhoea arborea;* grass tree, *Xanthorrhoea media*). Dominant culturally significant ground cover species present were: *Gurgi* (soft bracken, *Pteridium esculentum*; soft bracken, *Calochlaena dubia*), *Bamuru* (spiny-headed mat-rush, *Lomandra longifolia*), pithy sword-sedge (*Lepidosperma laterale*), *Warabura* (sweet sarsaparilla, *Smilax glyciphylla*) and snake vine (*Stephania japonica*).

At the proposed *guwiyang* burn site, *Daynya* (common hop bush, *Dodonaea triquetra*) and *Gurgi* were dominant in the mid-ground story in some areas, potentially due to more recent hot prescribed fire or other disturbance events. These species are recognised as a ruderal species, which take advantage of disturbed sites that have been cleared or burned and can rapidly regenerate and dominate the understory (Floyd 1966, 1976; Tolhurst and Turvey 1992); Country et al. 2024). *Daynya* exhibits a facultative resprouting strategy, with basal resprouting and post-fire seedling recruitment (Floyd 1966; Knox and Clarke 2005). Fire-stimulated germination is jointly influenced by temperature and duration of soil heating, with hotter fires promoting this species in post-fire vegetation communities (Floyd 1966, 1976). While we found no published species-specific window for basal resprouting of *D. triquetra*, seedlings have been recorded as appearing within ~4 weeks post-burn (Floyd 1966). *Gurgi* is globally known as a competitive ground cover plant and fronds can rapidly recover after fire from the rhizomes (Tolhurst and Turvey 1992). Hamilton (1989) and Karjalainen (1982) recorded a four-fold increase in frond density following low and mild intensity fire, respectively; however, this species is known to reduce in abundance with time since fire (Brian et al. 1976; Loyn et al. 1980). Fire-responsive *Dybung/Mambara* (narrow-leaved geebung, *Persoonia linearis*) resprouts from basal stems, lignotubers, and roots following both low- and high-intensity fires, with stronger responses after low-intensity burns (Morrison and Renwick 2000).

We assessed the fire history of the monitoring sites over the last 50 years using the New South Wales (NSW) Government's prescribed burn and wildfire data (Table 1; DCCEEW 2010). The impact site, *Bidyiwung Badhu Nuru*, had been burnt three times in the last 50 years (Table 1). Most recently, in 2019, it was partly burnt (8.7%, ca. 78 m^2 of the 900m^2 impact plot) by an arson-related wildfire that mainly burnt the opposite side of the *Bidyiwung Badhu Nuru* track (Fig. 2). In 2018, a prescribed burn affected the entire impact monitoring plot as well as the 'Middle Site' control, and 22 years ago, in 2002, a wildfire burnt all four sites.

The 'Middle Site' control had the most similar burn history to the impact site (Table 1), while the 'Devlin's Creek' control burnt in 2010 and experienced several wildfires in the decades preceding. Terry's Creek had only burnt once in the last 50 years. According to JR, the proposed *Bidyiwung Badhu Nuru guwiyang* was "an historic cultural burn… It's the first time since the early colonial period that Dharug have burnt there" (Rey et al. 2025).

Dharug *Dhiyina guwiyang* process

Before the *guwiyang*, Dharug *dhiyina* ran a four-day workshop in March 2024 (Fig. 1) to culturally prepare the site. One week before the cultural burn, the Dharug *dhiyina* manually trimmed the *Daynya* stems (from ~2 m to ~50 cm) to reduce the fuel load and likelihood of intense burning, as they wanted to impart a 'cool' traditional *guwiyang*. The *guwiyang* was undertaken across four days in late April 2024, led by the Dharug *dhiyina*, alongside Indigenous and non-Indigenous community members, stakeholders, and the National Parks and Wildlife Service staff. As outlined in Rey et al. (2025), Dharug *dhiyina* led the burn, beginning at the highest point of the site (west) and moving across in groups, using multiple ignition points to create fire mosaic patches or circles. Rake hoes were used to create containment lines and control the fire. Rain in the weeks leading up to the burn (Fig. 3) meant that the fuel was moist and the vegetation and leaf litter was difficult to ignite and hence, the fire spread slowly. As the temperature increased during the day, the fire spread more easily. Some plants species, such as *Gurgi*, were especially slow to catch fire, requiring encouragement to alight through dried *Gulgadya* leaves (Rey et al. 2025). Some of the previously cut *Daynya* stems did not fully burn. Average wind speed was 17.25 km/h in the morning and 16.25 km/h in the afternoon, with a mean maximum temperature of 23 °C and minimum of 12.4 °C over the four days (Bureau of Meteorology 2025). There was substantial rain in the week following the burn (~13.26 mm) (Fig. 3).

Eco-cultural monitoring

At each impact and control site, we established six 10 × 15 m grids with three nested 1 m^2 quadrats (randomly generated) within each grid cell (Fig. 4). The following assessments were conducted within this schema.

Guwiyang assessment

To assess fuel hazard changes at the impact site before and after the *guwiyang*, leaf litter depth (mm) was measured using a ruler within each quadrat as a measure of surface fine fuel load. Additionally, percent vegetation cover below 2 m was visually estimated as a measure of near-surface (≤0.6 m) and elevated (0.6–2 m) fuel strata, as defined by Hines et al. (2010). These low-mid storey cover data were combined into a single metric for rapid assessment. At nine to ten ignition points on each of the three burn days, we measured: (1) the rate of spread (how many metres the fire moved in one minute); and (2) the flame height at each ignition point

Table 1 Fire histories and time since last fire of each impact and control monitoring site, including bushfires (BF) and prescribed burns (PB) (DCCEEW 2010)

Site Name	Fire Histories	Time Since Last Fire (from 2024)
Terry's Creek	2002 (BF)	22 years
Bidyiwung Badhu Nuru	2019 (BF), 2018 (PB), 2002 (BF)	5 years
Middle Site	2018 (PB), 2002 (BF), 1993/1994 (BF)	6 years
Devlin's Creek	2010 (PB), 2002 (BF), 1993/1994 (BF), 1976 (BF)	13 years

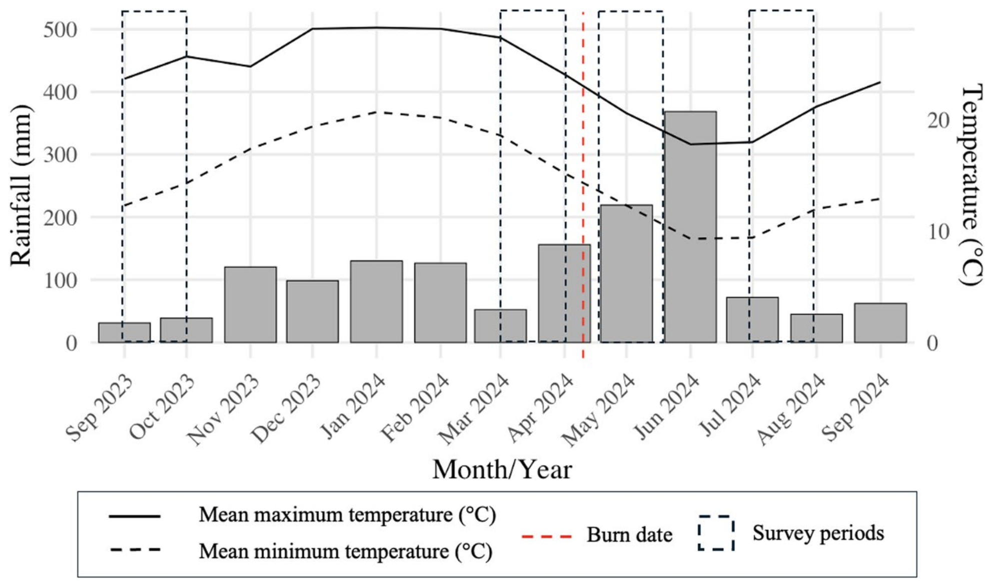

Fig. 3 Monthly mean maximum and minimum temperature (°C) and rainfall (mm) during the monitoring period. Data source: Bureau of Meteorology (2025)

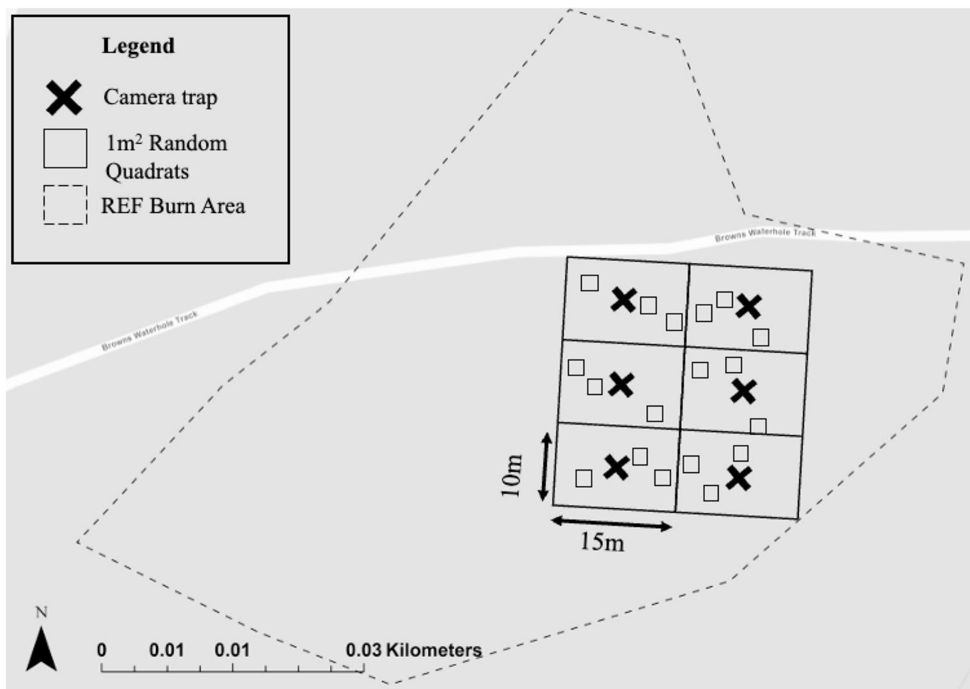

Fig. 4 Monitoring schema at the impact (*guwiyang*) site at *Bidyiwung Badhu Nuru* including six camera traps (X) and three randomly allocated 1 m² vegetation quadrats per grid cell. This schema was mirrored at control sites

(visual estimate) (McStephen 2014; AFAC 2015). Following the burn, we measured scorch height and proportion of area burned (patchiness) in each $1m^2$ quadrat ($n=18$) (Ooi et al. 2006; McStephen 2014; McKemey et al. 2019).

Dharug culturally significant plants survey

Surveys of select Dharug culturally significant plants (*Daynya*, *Gurgi* and *Dybung/Mambara*) were conducted before (early April 2024) and after the *guwiyang* (mid-July 2024) (Fig. 1). Within the $1m^2$ quadrats, we counted all *Daynya* stems (dead, or alive with foliage), post-fire resprouting stems and seedlings. We visually estimated *Gurgi* frond percentage cover in the $1m^2$ quadrats. Within each grid cell, we counted the number of resprouting *Dybung/Mambara* shoots at the base of adult plants (Morrison and Renwick 2000; Benwell 2024), with clusters of shoots counted as one.

Soil properties

Soil samples were taken at randomly generated locations within each grid cell at each site, one week before and one week following the *guwiyang* (Fig. 1). Soil samples were collected using a 10 cm steel core ring and placed in sealed plastic bags and stored at 4 °C prior to analysis. From each sample, a 50 g sub-sample was weighed and oven-dried at 105 °C for four days, then re-weighed to determine soil water content (differential weighing method; (O'Kelly 2004). After weighing 10 g sub-samples, rocks and organic material (e.g., leaf debris, twigs) were removed, and the remaining soil was finely ground. From this, we measured carbon content (loss on ignition), pH and electrical conductivity. For loss on ignition, 3 g of soil was placed in a crucible, heated at 550 °C for four hours, and re-weighed (Hoogsteen et al. 2015). pH and electrical conductivity were measured from a 1:5 soil-to-water solution (5 g soil:25 g water) using a Multi-parameter PCSTestr 35 probe.

Dharug culturally significant fauna survey

Camera traps were used to detect ground-dwelling Dharug target animals across four survey periods: six months before (September/October 2023), six weeks before (March/April 2024), immediately after (May/June 2024) and three months after (July/August 2024) the *guwiyang* (Fig. 1). Six Reconyx HP2W cameras were deployed at each site with one placed in each grid cell, approximately 15 m apart, for 35 trap days per period. Cameras were fixed to trees, and vegetation was cleared directly in front of the camera to avoid false triggers. Cameras were set to white flash, capturing three pictures per second with high sensitivity. Cameras were placed 40 cm above ground and facing down at a 45 degree angle (Meek et al. 2012; Gigliotti et al. 2022). A peanut butter, honey and oat lure was used in a PVC pipe bait station (Paull et al. 2011), mounted on a star picket with cable ties, and placed 1.2 m from the camera. An active 'lure' survey approach was adopted, to increase likelihood of animal detection and strengthen data analysis (following Miritis et al. 2024; Watchorn et al. 2024). Fauna monitoring methods were approved by Macquarie University Animal Ethics Committee (Reference number: 520251964364056), and consent for monitoring was approved by NSW National Parks and Wildlife Services (Reference number: DOC22/1022834).

Data analysis

During the Dharug *dhiyina guwiyang*, one grid cell did not burn, so only five cells from each monitoring grid were used for each site to balance the data. Statistical tests were dependent on data characteristics, including distribution, sample size, and study design (see Supplementary Table S1 for a summary of statistical analysis type). All analyses and figures were conducted using R Studio (Version 12.1; R Core Team 2024). Maps were made using ArcGIS Pro (Version 3.1.0).

Fire intensity and fuel hazard analysis

At the impact site, paired Wilcoxon signed-rank tests were used to assess differences in leaf litter depth (surface fine fuel) and vegetation cover below 2 m (near-surface and elevated fuel). Means were interpreted against fuel hazard strata thresholds defined by Hines et al. (2010). Fire intensity measures were averaged across samples and reported as means with standard error and sample size. Observed fire intensity was determined using standard fire monitoring codes developed by McStephen (2014).

Plant analysis

Dybung/Mambara reshooting stems were log-transformed and analysed using linear mixed effects models (grid number as random effect), to assess any differences between the impact site and two of the three control sites where they were present. Residual diagnostics were conducted to evaluate assumptions of normality and homoscedasticity, alongside a Shapiro–Wilk test for normality of residuals.

To compare living *Daynya* stem counts and *Gurgi* frond cover before and after the fire, we used the Wilcoxon signed-rank test, given the non-normal distribution of the data and the repeated-measures design. These were only analysed at the impact site, *Bidyiwung Badhu Nuru*, as they were limited at the control sites, and the Dharug *dhiyina* wished to understand whether this species would decline in abundance after the cultural burn.

Soil analysis

Each soil property (pH, EC, soil moisture and carbon content) was analysed separately using linear mixed effects models (grid number as random effect) to assess any potential impact of the *guwiyang* compared to the control sites. Residual diagnostics were conducted to evaluate assumptions of normality and homoscedasticity for each model. Additionally, Shapiro–Wilk tests were used to test for normality of residuals.

Fauna analysis

For each animal detection, camera trap images were tagged with date, event duration (start and end time) and species (*Bagarayi* (swamp wallaby; *Wallabia bicolor*) and *Burraga* (long-nosed bandicoot; *Perameles nasuta*). Given the proximity of cameras within each site and the small scale of the burn, we pooled detections from all cameras within a site to avoid pseudo-replication and overinflating detection estimates. For each site, daily species detections were aggregated and recorded as present (1) or absent (0) per day within each survey period (Miritis et al. 2024). Presence/absence data were aggregated across survey periods, with the response variable defined as species activity (Parkins et al. 2019; Miritis et al. 2024; Watchorn et al. 2024), which was calculated as the number of days present divided by the total number of days within each survey period.

To assess whether *Burraga* and *Bagarayi* activity responded to the *guwiyang*, we employed generalised linear mixed models (GLMMs) with binomial errors and a logit link function for each species (Bolker et al. 2009; Pardini et al. 2018). The model tested whether the interaction between survey period and treatment type (the BACI effect) explained significant variation in species activity (as in Pardini et al. 2018). The two pre-burn surveys were grouped as 'before' and the two post-burn surveys as 'after'. In the model, *Bidyiwung Badhu Nuru* was specified as the impact site and used as the reference level, while the three control sites were included individually to enable direct comparisons. All models were fit using the *glm* function from base R. The significance of fixed effects was assessed using Type III Wald's χ^2 tests (likelihood ratio tests) using the *car* package (Bolker et al. 2009; Fox and Weisberg 2018). Model fit was evaluated using McFadden's R^2, calculated with the *pscl* (Jackman 2024) and *performance* packages (Lüdecke et al. 2021). Assumptions were assessed using *DHARMa* package (Hartig 2024) to examine residual distributions and check for overdispersion. Post hoc pairwise comparisons of estimated marginal means were conducted using the *emmeans* package (Lenth 2025) to test before-and-after changes within each site.

Results

Guwiyang intensity and fuel hazard assessment

Following the *Bidyiwung Badhu Nuru guwiyang*, there was a significant reduction in leaf litter depth (V=114, p=0.002), which declined from 30.3 mm (±10.6 mm SE, n=15) to 8.3 mm (±9.4 mm SE, n=15). According to Hines et al. (2010), this shift suggested a reduction in surface fine fuel hazard from high (≥20 mm) to low (<10 mm). Mean vegetation cover below 2 m significantly decreased from 58.0% (±19.8% SE) to 19.0% (±12.4% SE) (V=119, p=0.0009). Based on cover thresholds, this corresponded to a decline in low-mid storey fuel hazard from high (>50%) to low–moderate (10–40%) across the near-surface and elevated fuel strata (Hines et al. 2010). During the burn, the estimated mean flame height was 0.96 m (±0.1 SE, n=28) and the rate of spread was 0.48 m/minute (±0.04 m SE, n=28). On average, 52.67% (±7.74% SE, n=15) of each quadrat was burnt, and the mean scorch height was 1.1 m (±0.19 m SE, n=15). According to protocols outlined by McStephen (2014), the observed fire intensity was low, as it was patchy, did not remove all the litter and ground stratum, and there was very low scorch with no canopy scorch.

Dharug culturally significant plant responses

There were significantly more *Dybung/Mambara* shoots after the *guwiyang* (β = −0.88, SE=0.20, p<0.001). The interaction effect indicated that the before-after changes at Devlin's Creek (β=0.72, SE=0.29, p=0.021) and Terry's Creek (β=0.88, SE=0.29, p=0.006) were significantly different from the impact site. Post hoc results showed no significant change at Devlin's Creek or Terry's Creek (p>0.4), indicating that the observed increase was confined to the *Bidyiwung Badhu Nuru guwiyang* site.

After the *guwiyang*, significant reductions in living *Daynya* stems (V=28, p=0.022) and *Gurgi* frond cover (V=75, p=0.005) were detected. However, we reiterate that the Dharug *dhiyina* did manually cut the *Daynya* stems before the burn (in fear of fire risk), which may have influenced this result. Four *Gurgi* fronds were observed within weeks after the fire.

Dharug soil responses

Soil moisture increased at all sites following the *guwiyang*, including at *Bidyiwung Badhu Nuru* where the increase was statistically significant (β = −10.5, SE=3.11, p=0.002; Fig. 5). However, no significant interaction was found between site and survey period, indicating that similar increases were also observed at control sites (Devlin's Creek: β=4.99, p=0.27; Middle Site: β=5.47, p=0.22; Terry's Creek: β=4.30, p=0.34).

No significant changes were detected in soil carbon, pH, or electrical conductivity after the *guwiyang* at *Bidyiwung Badhu Nuru*. No significant interaction effects were found between site and survey period, indicating that any variation observed at the impact site was comparable to that at control sites (Fig. 5; see Supplementary Table S2 for full model outputs). However, the mean percent soil carbon at *Bidyiwung Badhu Nuru* was notably higher after the fire compared to before the fire, a trend that was not observed for the three control sites (Fig. 5).

Dharug culturally significant fauna responses

We found no substantial effect of the *guwiyang* on important Dharug fauna species over the study period

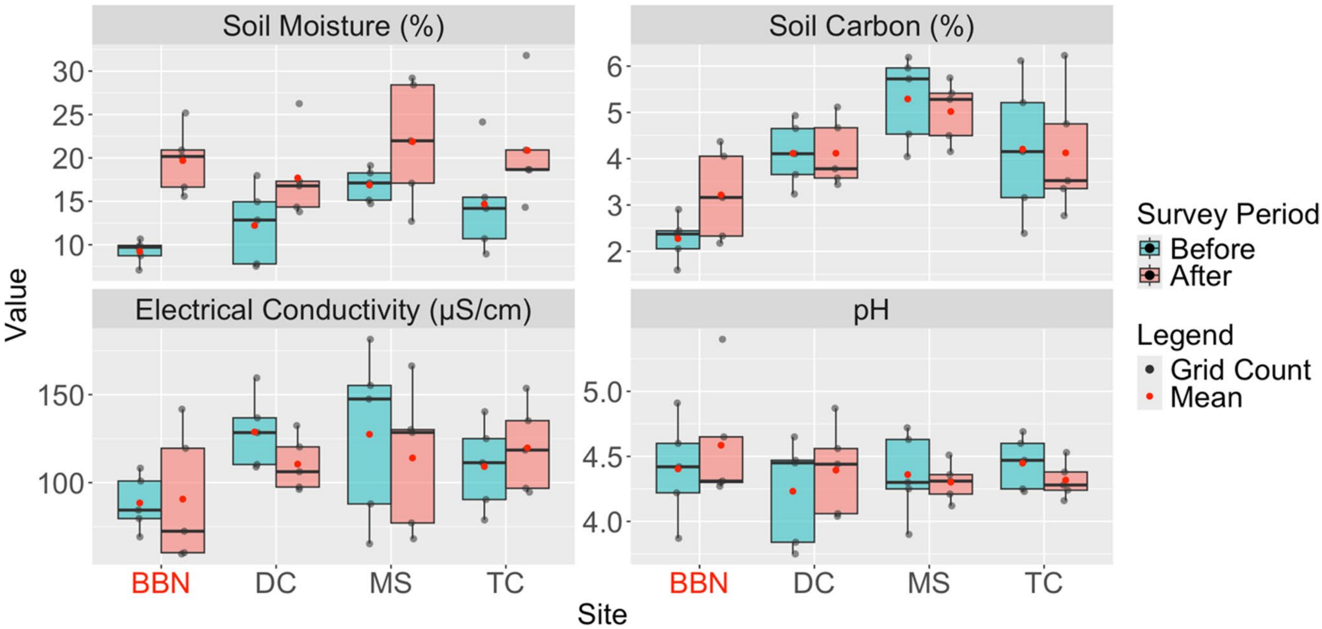

Fig. 5 Responses of soil variables at impact and control sites before and after the *guwiyang*, including soil moisture (%), soil carbon (%), electrical conductivity (mS/cm), and pH. Site abbreviations: *Bidyiwung Badhu Nuru* (BBN), Devlin's Creek (DC), Middle Site (MS), and Terry's Creek (TC)

compared to the control sites. *Burraga* activity before and after the *Bidyiwung Badhu Nuru guwiyang* did not differ significantly from that at other sites (χ^2 = 2.54, df = 3, $p = 0.468$). Model-estimated activity probabilities showed a significant decline in *Burraga* activity across all sites (Fig. 6; see Supplementary Table S3 for full model outputs). At *Bidyiwung Badhu Nuru*, activity dropped sharply ($p = 0.0002$), representing an ~8.6-fold reduction. Similar but less pronounced declines were observed at the control sites: Devlin's Creek declined ~2.7-fold ($p = 0.045$); Middle Site ~4.1-fold ($p = 0.017$); and Terry's Creek ~4.5-fold ($p = 0.011$). DHARMa residual diagnostics indicated no evidence of overdispersion or poor model fit. The model explained 34.6% of the variance in

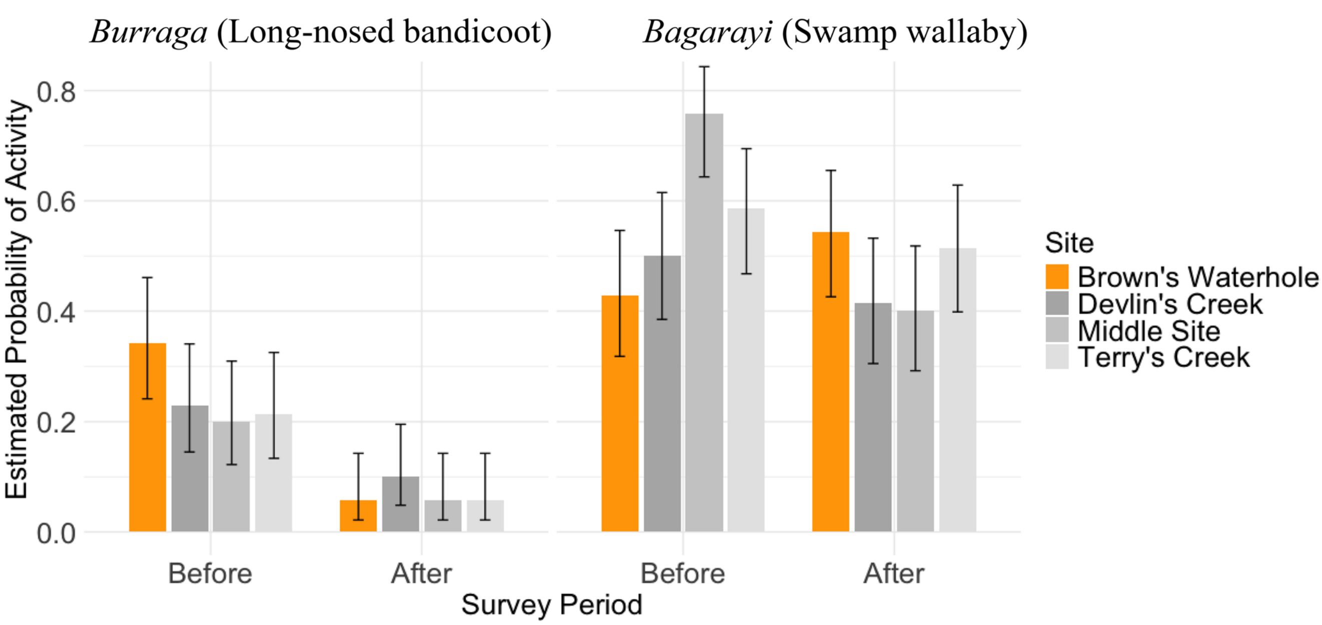

Fig. 6 Estimated activity (proportion of days detected) of *Burraga* (Long-nosed bandicoot) and *Bagarayi* (Swamp wallaby) across pooled before and after survey periods at impact and control sites. Prediction probability estimates were obtained from the binomial GLMM. Bars show mean predicted probabilities of activity, with 95% confidence intervals

Burraga activity (McFadden's R^2), indicating a moderately strong fit.

Changes in *Bagarayi* activity before and after the *guwiyang* differed between sites ($\chi^2 = 16.70$, df=3, $p<0.001$) (Fig. 6). A significant difference was only detected for Middle Site, where activity was reduced by nearly half ($p<0.001$). We found no significant differences in *Bagarayi* activity before-after the *guwiyang* at *Bidyiwung Badhu Nuru* (~1.3-fold, $p=0.177$), Devlin's Creek (~1.2-fold decline, $p=0.309$) or Terry's Creek (~1.1-fold decline, $p=0.396$). Residual diagnostics confirmed appropriate model fit and no overdispersion. The model explained 20.6% of the variance in *Bagarayi* activity (McFadden's R^2).

Discussion

Despite the resurgence of Indigenous cultural burning for ecological and cultural purposes (Maclean et al. 2023), there is a paucity of Indigenous-led burning and associated research in urban landscapes, especially by women. The present paper addressed this research gap through eco-cultural monitoring of a Dharug *dhiyina* women-led *guwiyang* (fire) event in the urban-bushland interface of Lane Cove National Park, Sydney, Australia. Eco-cultural responses of 'other-than-humans' were varied and nuanced, but overall provided evidence for the low ecological impact of the *guwiyang* at *Bidyiwung Badhu Nuru* (Brown's Waterhole), and aligned with the Dharug *dhiyina* objectives for the burn (Rey et al. 2025). Evidence of the impacts of Indigenous-led cultural burns in urban areas are necessary to guide decisions about inclusion of Indigenous peoples and knowledge in urban ecosystem management and to reduce barriers related to fear and lack of data (Williamson 2022; McCormack et al. 2024). Notably, this *guwiyang* and the associated research was led and guided by Dharug *dhiyina*, addressing a critical gap in Indigenous women led conservation which has been notably suppressed in European colonised nations (Sithole et al. 2008; James et al. 2021; Cavanagh 2022; Rey et al. 2025).

Fuel and fire behaviour of the Bidyiwung Badhu Nuru guwiyang

Post-burn reductions in surface fine fuels and near-surface/elevated fuels (Hines et al. 2010) suggested that the Dharug *dhiyina guwiyang* lowered fuel hazards at *Bidyiwung Badhu Nuru*, aligning with the first Dharug *dhiyina* objective. Burning intensity measures confirmed the patchy, low-intensity approach that was preferred by the Dharug *dhiyina*, aligning with other cultural burns studied in eastern Australia (McKemey et al. 2019). Furthermore, the Dharug *dhiyina guwiyang* fell within or below the recommended prescribed burning thresholds for rate of spread and flame height for sclerophyll forests (McCarthy 2004; AFAC 2015; Cruz et al. 2015).

These research outcomes are noteworthy given the colonial legacy of distrust and suppression of Indigenous fire practices (Cahir et al. 2018; Hoffman et al. 2021). While public attitudes are shifting, fear of fire (such as escape risks, smoke and ecological consequences) often limit public support for burning in populated urban-bushland areas (Cortner et al. 1990; Bell and Oliveras 2006; Altangerel and Kull 2013). The results of the present study, although limited in spatial scale, add to the growing evidence that cultural burning, like other low-intensity, patchy burns, can reduce fuel loads (McCarthy 2004) and wildfire risk (Boer et al. 2009; Penman et al. 2011) to protect habitats for fire-sensitive species (Pastro et al. 2011). Paradoxically, in some places there is also concern that burning can be too frequent or intense, potentially affecting regeneration, promoting vegetation thickening and also affecting fauna habitat (Altangerel and Kull 2013). Small scale and community-inclusive burns such as the one presented in this study, while resource-intensive, do offer the opportunity for social learning and low-impact burning, which are important for the urban-bushland context. Therefore, for complex fire management in the urban-bushland interface, cultural burning may offer a complementary approach to mainstream fire management, with not only ecological benefits and reduced wildfire risk, but also socio-cultural benefits that align with international and national goals for enhancing Indigenous and social inclusion in conservation and science (Price et al. 2012; McKemey et al. 2019; Country et al. 2024; McCormack et al. 2024).

'Other-than-human' responses to the Bidyiwung Badhu Nuru guwiyang

Plants

This study affirmed the Dharug *dhiyina guwiyang* objectives for the promotion of culturally valued plant species, particularly the medicine and food plant, *Dybung/Mambara* (narrow-leaved geebung), which responded by producing regenerative shoots. This species is known to tolerate both low- and high-intensity fires by resprouting from basal trunks, lignotubers, or root systems. Notably, low-intensity burns typically yield a higher number of shoots, which may enhance the long-term persistence of the species (Morrison and Renwick 2000) and produce fresh shoots of medicinal value. However, it is important to consider that other factors, including reduced competition, increased light and nutrient availability, and altered climatic conditions, may have also contributed to the reshooting response (Benwell 2024).

The *Bidyiwung Badhu Nuru guwiyang* also aligned with the Dharug *dhiyina* objectives to reduce the dominance of *Daynya* (common hop bush) stems and *Gurgi* (bracken) frond cover. Three months after the fire we observed some resprouting from both species; however, this was lower than expected given their known fire-responsiveness (Floyd 1966, 1976; Tolhurst and Turvey 1992; Spencer and Baxter 2006). Previous research has shown that regeneration of *Daynya* is favoured by hot fires (Floyd 1976) and seed germination is promoted by high temperature and short duration heating (peaking around 100 °C for ~ 10–60 min; (Floyd 1966). In contrast, *Gurgi* resprouts from rhizomes and often dominates the understory under frequent, low-intensity fire regimes (Tolhurst and Turvey 1992). Given the limited resprouting responses detected in the present study, our initial results suggest that low-intensity cultural burning and trimming of *Daynya* may reduce the short-term dominance of both species at this site. However, longer-term monitoring is required, especially as herbivory was not monitored (Chard et al. 2022), and for *Gurgi*, whose regeneration can peak in the spring-summer period after a fire (Tolhurst and Turvey 1992). The trimming of *Daynya* stems from ~2 m to ~50 cm prior to burning potentially also supressed the soil temperature-duration threshold that has been reported as stimulating *Daynya* germination (Floyd 1966). Given the scarcity of resprouts and seedlings, pre-burn trimming followed by a low-intensity *guwiyang* warrants controlled trials to test its effectiveness at reducing *Daynya* dominance and to disentangle trimming from fire effects.

Soils

The Dharug *dhiyina* expressed great interest in understanding changes in soil properties following the *guwiyang* (Rey et al. 2025), given the role of soil in post-fire ecological recovery (Calderisi et al. 2025) and limited examination of soil responses to Indigenous-led low-intensity cultural burning (although see Country et al. (2024). The Dharug *dhiyina* sought to understand how fire affected soil properties rather than produce a particular outcome. We found that soil carbon did not change significantly, consistent with other low-intensity fires (e.g., Granged et al. 2011; Plaza-Álvarez et al. 2017); however, there was a trend for higher carbon at *Bidyiwung Badhu Nuru* after the *guwiyang* compared to the control sites. Other studies have detected substantial increases in carbon following Indigenous-led low-intensity and moderate-intensity prescribed burns (Granged et al. 2011; Country et al. 2024). This has been attributed to black carbon produced from partially combusted material at lower temperatures (Xifré-Salvadó et al. 2021), which is often visible as black ash—an indicator of cool-burning, also noted by the Dharug *dhiyina* in conversation. Although not statistically significant, the higher mean post-fire carbon at *Bidyiwung Badhu Nuru* may be indicative of small char inputs.

No significant changes in soil moisture, pH, or electrical conductivity were measured after the *guwiyang*. While responses in soil moisture and pH have been shown to vary in some other low-intensity fire studies (Granged et al. 2011; Country et al. 2024), the stability of electrical conductivity observed here aligned with findings by Granged et al. (2011). Overall, these outcomes likely reflected the low intensity and patchy *guwiyang* and were possibly influenced by the rain fall soon after the fire and low ash input from incomplete biomass combustion.

Fauna

The *Bidyiwung Badhu Nuru guwiyang* also had limited effects on *Bagarayi* (swamp wallaby) and *Burraga* (long-nosed bandicoot) activity. Previous research has shown that swamp wallabies can respond positively to fire, which stimulates the regrowth of preferred food sources such as fungi and grass (Stefano et al. 2009; Chard et al. 2021). In the present study, camera trap photos captured *Bagarayi* feeding on newly emerged fungi and grasses within a month post-burn, coinciding with a slight, though non-significant, increase in activity, mirroring short-term trends observed by Chard et al. (2021). Despite known preferences for areas with dense understorey (Fischer et al. 2019), our results suggested that changes to low- and mid-storey vegetation following the burn did not greatly influence *Bagarayi* at *Bidyiwung Badhu Nuru*. This may be due to the patchy nature and small scale of the burn, which maintained surrounding refugial habitat and likely mitigated potential for the increased predation risk (Chard et al. 2021).

Burraga activity decreased across all sites, with the most pronounced drop observed at the burn site. While this reduction might indicate some sensitivity to fire, similar declines at the control sites suggest climatic influences. *Burraga* foraging is known to increase with warmer temperatures and moist soils that support invertebrates and hypogeous fungi, which are key food resources that decline under dry conditions (Claridge and Barry 2000; Hughes and Banks 2011). *Burraga* reproductive activity in other Sydney-based urban-bushland populations was shown to peak in late spring and summer, declining during the colder months, likely due to energetic constraints and reduced food availability (Scott et al. 1999). This seasonal variation can, in turn, influence detection probabilities throughout the breeding season (MacGregor et al. 2020). Taken together, cooler post-burn temperatures and fluctuating rainfall likely influenced both foraging and detectability of *Burraga* across all sites. Long-term monitoring would be beneficial for disentangling fire-related effects from broader ecological and climatic trends.

The mammal responses studied here are particularly relevant within urban-bushland interfaces where remnant vegetation is fragmented, frequently disturbed, and bounded by residential development. In such landscapes, fauna must navigate a range of non-fire stressors, including habitat degradation, edge effects, and human activity that may compound or obscure responses to fire. The limited impacts observed here suggest that patchy, low-intensity *guwiyang* can be beneficial for these species in urban-bushland settings by maintaining habitat mosaics (Scott et al. 1999). Such practices may offer a culturally grounded alternative to conventional prescribed burns—typically larger and hotter—with potentially lower fauna disturbance (McKemey et al. 2019), contributing to a more nuanced approach to fire management in fragmented urban landscapes.

Implications for management and study limitations

This study examined the impacts of a relatively small cultural burn in an urban National Park, providing rare insights into the responses of eco-cultural 'other-than-human' entities. Due to bureaucratic processes, fear of fire, and the lack of broader public understanding and trust of Indigenous fire in urban landscapes, an important outcome of this research was to demonstrate that low-intensity cultural burns can be conducted with minimal impact. Using a standard Western ecological BACI assessment of Dharug *dhiyina*-defined values, we showed that the Dharug *dhiyina*-led *guwiyang* was low-intensity and patchy, effectively reducing surface and near-surface/elevated fuel loads, while having minimal impacts on fauna and soil. Additionally, we quantified the positive effects of the cultural *guwiyang* in decreasing the prevalence of dominant plant species whilst promoting a culturally valued medicinal and food species. The results contribute to growing evidence that Indigenous-led fire events, when applied appropriately, can support healthy ecosystems, cultural revitalisation and mitigate wildfire risk (Cortner et al. 1990; Hoffman et al. 2021). While our findings may have broader relevance, urban settings have distinctive features—such as native–exotic vegetation composition, size of remnant bushland patches, and Indigenous cultural associations—that could produce different responses to cultural burning than those detected in the present study. Furthermore, economic and resourcing constraints (e.g., personnel, equipment, permits) may determine the scale and frequency of Indigenous-led burns, and these constraints would likely influence ecological and cultural outcomes.

The outcomes of this study also underscore the benefit of cross-cultural collaborative monitoring approaches which, in this context, combined Dharug values with Western scientific methods, fostering opportunities for respectful collaboration, shared learning, and joint decision-making in fire management (Ens et al. 2015; McKemey et al. 2022; Maclean et al. 2023). Other cultural outcomes of this *Bidyiwung Badhu Nuru guwiyang*, as noted in a complementary publication (Rey et al. 2025), included increased confidence of the Dharug *dhiyina* to conduct burning in the urban-bushland interface.

Results from this study suggest the likely benefit of follow-up burning to enhance Dharug desired outcomes and values for *Ngurra*. Follow-up burning may further suppress dominant or invasive flora and trigger regeneration from existing seed banks of fire-dependent species (McKemey et al. 2021). Although this *guwiyang* reduced the locally dominant *Daynya*, fire in urban landscapes can initiate or reinforce invasive plant–fire cycles (Brooks et al. 2004; Fusco et al. 2022). Ongoing monitoring is warranted to understand whether repeated low-intensity cultural burns suppress or inadvertently promote problem species. Additionally, burning at different times of the year at different sites could enhance the mosaic of vegetation types and growth stages, as well as refugia and resource availability for fauna (Bird et al. 2018; McKemey et al. 2019) and reducing fuel loads and bushfire risk (McKemey et al. 2019; Hoffman et al. 2022). By centring Dharug preferred cultural values and 'more-than-human' responses in the monitoring design, this study offers an example of how Indigenous fire application and cross-cultural science can operate within highly regulated urban-bushland interfaces. These approaches are becoming increasingly relevant in global efforts to enhance Indigenous stewardship in climate-resilient land care.

Conclusions

This study provided rare empirical evidence of the eco-cultural outcomes of an Indigenous women-led cultural burn within an urban-bushland interface. Globally, where Indigenous fire practices have been disrupted by colonisation, institutional barriers, and risk-averse policies, these findings demonstrate the potential for small scale Indigenous women's-led burning to contribute meaningfully to biodiversity conservation, wildfire risk reduction, and the restoration of cultural relationships with Country, even in densely populated landscapes. In the face of escalating climate-driven fire risks, small-scale, low-intensity cultural burning presents an adaptive, place-based strategy to mitigate fire risk while enhancing eco-cultural resilience in urban ecosystems. By centring Indigenous leadership and cross-cultural knowledge exchange, this work offers an approach for reimagining fire management through culturally grounded and ecologically informed collaboration.

Appendix 1

Table 2 Glossary of Dharug terms

Dharug	English
Bamuru	Mat-rush grasses (including spiny-headed mat-rush, *Lomandra longifolia,* and pithy sword-sedge, *Lepidosperma laterale*)
Bidyiwung Badhu Nuru	Brown's Waterhole
Burraga	Bandicoot (including long-nosed bandicoot, *Perameles nasuta*)
Baragayi	Swamp wallaby (*Wallabia bicolor*)
Daynya	Common hop bush (*Dodonaea triquetra*)
Dhiyina	Women
Dybung/Mambara	Geebung (*Persoonia* species)
Gulgadya	Grass Tree (including broadleaf grass-tree, *Xanthorrhoea arborea,* and grass tree*, Xanthorrhoea media*)
Gurgi	Bracken (including bracken fern, *Pteridium esculentum*, and soft bracken, *Calochlaena dubia*)
Guwiyang	Fire
Ngurra	Country
Warabura	Sweet sarsaparilla, *Smilax glyciphylla*

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11252-025-01839-8.

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Author contributions All authors contributed to the study conception, design, analysis, interpretation and documentation. Material preparation, data collection and analysis were performed by GB. The first draft of the manuscript was written by GB and all authors contributed thereafter. All authors read and approved the final manuscript.

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Data availability The datasets generated during this study are not publicly available due to cultural and ethical considerations. The project involved co-designed monitoring with Dharug Traditional Owners, whose knowledge and values informed the research. Any requests for access to data should be made in consultation with the Dharug Women's and Allies Cultural Fire Alliance and the corresponding author, and will be considered in line with principles of Indigenous data sovereignty and ethical research practice.

Declarations

Competing interests The authors declare no competing interests.

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