Punching above their weight: the ecological and social benefits of pop-up parks

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Abstract

Current global enthusiasm for urban greening and bringing nature back into cites is unprecedented. Evidence is mounting for the socio-ecological benefits of large, permanent greenspaces, but the potential for pop-up parks (PUPs) – small, temporary greenspaces – to synergistically enrich urban nature for the benefit of biodiversity and people is unknown. Here, we firstly highlight the potential of PUPs to provide biodiversity benefits by drawing on a case study to show how PUPs may enhance biodiversity in a densely-urbanised area. Next, we review the evidence linking greenspace design with social outcomes to consider the potential of PUPs to deliver social and mental restoration benefits. Finally, we highlight how PUPs can function as socio-ecological laboratories for conducting experiments that inform urban design, and propose a research agenda to address the pressing need to understand how small, temporary greenspaces may be optimally designed to provide socio-ecological benefits to humans and other species..

In a nutshell

- Pop-up parks have swiftly evolved into a worldwide phenomenon, driven by the recognition of the value of greenspace for humans and other species.

- The food and habitat resources provided by PUP can boost and sustain functionally and taxonomically diverse insect communities.
- Pop-up parks may help people rekindle their connections with nature, socialise, spend time outdoors, and experience positive short-term body and mind states.
- Pop-up parks provide insight into how small, temporary greenspaces can complement permanent greenspaces in incorporating nature into cities.
- Pop-up parks offer a platform for addressing targeted ecological and social research questions related to greenspace design.

Urban ecosystems are increasingly valued for their environmental and social outcomes (Hartig and Kahn 2016), with increasing attention being paid to the design and management of urban greenspaces (Aronson *et al.* 2017). The socio-ecological benefits of greenspaces are reported to be substantial. Urban nature can have positive effects on physiological and psychological health (Shanahan *et al.* 2016), and both physical and mental well-being correlate with amount, proximity and access to greenspaces (Hartig *et al.* 2014). Furthermore, greenspaces in urban environments provide vital resources for biodiversity (Sadler *et al.* 2010; Beninde *et al.* 2015; Lepcyyk *et al*. 2017; Threlfall *et al.* 2017), including for threatened species (Ives *et al.* 2016). Conserving and increasing biodiversity in cities is an urban sustainability imperative, chiefly because of the key roles that plants, animals and other non-human species play in sustaining functional, healthy ecosystems (Cardinale et al. 2012), and delivering ecosystem services (Mace et al. 2012). For these reasons, there is worldwide enthusiasm for urban greening (Hartig and Kahn 2016), with particular interest from planning, landscape and health practitioners seeking to bring nature back into cities. While we acknowledge the central role of large, permanent greenspaces, this paper draws attention to the emerging opportunity presented by small-scale, short-lived greenspaces such as pop-up parks (PUPs) to synergistically enrich urban nature for the benefit of biodiversity and people.

In simplest terms, a PUP is a small, temporary greenspace (Figure 1a-c). Yet PUPs can vary considerably in size and duration. Some may occupy a few square meters (e.g. a planter box), while others extend over much larger areas (e.g. Melbourne's 3,000 m^2 'A'Beckett Square'; Figure 1b). Pop-up parks may be extremely short-lived; the first Park(ing) day in 2005 transformed a metered parking space into a PUP for the term of the two-hour stipulated lease. Ultimately, a PUP's duration will depend on the factors that determined its creation. For example, a PUP may be used as a test-run for a permanent greenspace, to reassign the use of location to reflect the changing seasons, or become the 'meanwhile' use of a site that has been scheduled for redevelopment (Kelly 2012).

From their inconspicuous inception in the late twentieth century (Lydon and Garcia 2015), PUPs have swiftly evolved into a worldwide phenomenon. For instance, the Park(ing) Day project – an ongoing annual worldwide initiative where parking spots are transformed into PUPs – has grown into a global movement, with over 1,500 PUPs created on PARK(ing) Day 2013 (Corey 2014; Figure 2). This and other community-led PUP initiatives have now morphed into more formal institutionalised programs. A notable example is the San Francisco Planning Department 'Pavement to Parks' program, an initiative that transformed under-utilised street space into public plazas and parks that existed for days or years (Loukaitou-Sideris *et al.* 2012). As of 2014, at least 21 cities in North America were officially supporting or piloting similar PUPs programs (Corey 2014). Other municipalities around the world have also embraced PUPs as a strategic component of urban planning. The City of Greater Dandenong, Australia purposely incorporated PUPs into their 'Revitalising Central Dandenong' renewal project. In London, the Boroughs of Lambeth and Southwark have taken up the Design Council's 'Knee High Challenge', a program that specifically aims to use PUPs to increase the available outside-play-space for children and their parents.

Pop-up parks illustrate the concept of 'tactical urbanism', a global approach to urban planning and design focusing on short-term, low-cost greening initiatives to add vitality to vacant or under-utilised spaces (Lyndon and Garcia 2015). Pop-up parks are also part of the 'do-it-yourself' urbanism movement

(Finn 2014), in which residents take it upon themselves to plan and execute place-making initiatives to improve unaddressed issues in the public space realm. Public health scholars, practitioners and policymakers advocating for innovative approaches to promote urban liveability have included PUPs as community experiments in public health law and policy; for instance, PUPs were an important component of a series of public health actions implemented by the City of Minneapolis as part of a citywide effort to foster violence-free social environments that were instrumental in catalysing a 60% reduction in juvenile violent crime (McGowan *et al.* 2015). Given their flexibility to accommodate people for short time periods, PUPs have been cited as examples of emerging community amenities (Larson and Guenther 2012), attracting valuable social and economic activity around the places in which they are temporally located. Pop-up parks may also be considered an applied example of 'urban acupuncture', an environmentalist philosophy and theory that uses acupuncture as a metaphor for applying small-scale actions to address large-scale urban sustainability issues (Lerner 2014).

While a strong body of evidence is building for the socio-ecological benefits of large, permanent greenspaces (Sadler *et al.* 2010), no studies have investigated the potential socio-ecological benefits of PUPs. Here, we highlight the potential of PUPs to provide biodiversity benefits, and present empirical evidence of the potential for PUPs to deliver positive biodiversity outcomes using a case study conducted in a densely-urbanised area of Melbourne, Australia. Next, we review the direct or implied evidence from the literature regarding the potential social benefits of PUPs. Finally, we argue that a structured research agenda for exploring the socio-ecological benefits of PUPs and the best designs to achieve those benefits is urgently needed. Our focus on PUPs recognises the increasing lack of opportunity for decision-makers and urban planners to create new large, permanent greenspaces. Our research helps inform how small-scale, short-lived greenspaces such as PUPs may be optimally designed to provide socio-ecological benefits to humans and other species.

■ The biodiversity benefits of pop-up parks

A mounting body of evidence highlights the contribution of large, permanent greenspaces for sustaining biodiversity within urban environments. A recent meta-analysis of the factors influencing intra-urban biodiversity variation provided evidence of the positive effect of patch area on the species richness of numerous insect and vertebrate taxa, and suggested that sites of at least 50 ha are needed to sustain area-sensitive, urban-avoider species (Beninde *et al.* 2015). Additionally, and arguably much more importantly, the meta-analysis identified the critical contribution of biotic factors, such as vegetation structure and plant diversity, that operate in the urban matrix at much smaller scales and that have the potential to be targeted for management actions. Similarly, a study examining how a functionally diverse insect community responded to management-induced vegetation changes in a range of greenspaces found that, while large greenspaces such as golf courses sustained more species on average than smaller greenspaces such as residential gardens, the key driver of insect diversity was a synergistic combination of vegetation structure and plant diversity (Mata *et al.* 2017). Working within the same experimental context, Threlfall *et al.* (2017) showed that plot-level factors such as understory vegetation volume were more influential drivers of bat, bird, bee, beetle and bug diversity than the density of trees in the landscape. These studies suggest that localised biotic factors can be more substantial drivers of greenspace functional and taxonomical diversity than factors operating at large, landscape scales. In the context of greenspace design, these biotic factors are key site attributes, which, if properly managed, could contribute to the provision of food and habitat resources for a wide range of taxa in small-scale greenspaces. While we do not presuppose that all findings elucidated in these studies can be extrapolated directly to PUPs, we believe they highlight the untapped potential of small-scale greenspaces to deliver positive biodiversity outcomes if properly designed.

Beyond large greenspaces, many greenspace types in the size range of PUPs, such as flower meadows, pocket parks, residential gardens, and greenroofs, are playing critical roles in supporting biodiversity in cities (Aronson et al. 2017; Lepcyyk *et al*. 2017). Here, our focus is on greenroofs because of the substantial body of evidence produced in recent years supporting hypotheses linking greenroof design with positive biodiversity outcomes. For instance, a study across 40 greenroofs by Braaker *et al.* (2017) provides compelling evidence of the positive relationships between greenroof design features, such as plant diversity and flower abundance, and functionally and taxonomically diverse arthropod communities. Like PUPs, greenroofs are situated at the frontier of applied urban ecological research and practice (Oberndorfer *et al*. 2007), and face many of the same design challenges and considerations in order to achieve their full potential as providers of food and habitat resources for biodiversity in cities. The short lifespan of PUPs adds an extra element of complexity not shared with greenroofs. How the short lifespan of PUPs influences the number of species that successfully establish populations in them, the ecological implications of PUP removal for these populations, and the extent to which improperly-designed PUPs could act as ecological traps are appealing and topical avenues of research.

There is a need for experimental evidence that links key features of greenspace design with specific biodiversity outcomes. Guidelines have been developed for practitioners wishing to incorporate ecological knowledge into urban planning, design and development, including design guidelines expressly targeted at maintaining and introducing habitat (Garrard *et al.* 2018) and identifying species' critical life-cycle requirements (Weisser & Hauck 2017). Yet at present, the capacity for greenspaces to successfully deliver meaningful long-term biodiversity benefits is largely unknown. Evidence-based urban design that carefully considers the causal pathways linking design to biodiversity benefits will be key to the success of PUPs and other types of small-scale greenspaces for delivering positive biodiversity outcomes. Many questions remain, for instance: (1) can PUPs, notwithstanding their small size and short lifespan, be colonised by, and provide resources for, species in densely-urbanised areas? and (2) can PUPs contribute to the functional and taxonomical diversity, albeit temporarily, of the broader greenspace in which they might be embedded? Aiming to shed some light on these and other related questions, we present a case study of a small, temporary greenspace that embodies investigation of the biodiversity benefits of PUPs.

■ The 'Grasslands' case study

'Grasslands' was an art-science collaboration that temporally greened the State Library of Victoria, Melbourne, Australia by installing native grasses (Panel 1). We were interested in examining whether the short duration of the PUP would provide adequate time for an insect community to become established and, if so, whether this would lead to an increase in the site's overall insect diversity or just mirror the insect diversity of the site's permanent vegetation. We hypothesised that the site's gamma diversity would increase as a result of the unique insect species living in the PUP vegetation, and tested this across five functional and six taxonomical groups. A detailed description of our experimental design, data collection methodology and data analysis framework is given in Panel 1 and WebPanel 1.

Over the PUP's lifespan, we detected 90 insect species at the site, of which 20 were unique to the permanent vegetation, 41 unique to the PUP vegetation, and 29 shared between the two vegetation types. For each functional and taxonomical group, and for all groups combined, we estimated the contribution of the PUP to the site's overall insect diversity, expressed as a per cent change in species richness when compared to insects detected in the permanent vegetation only (WebPanel 6). Our results reveal that the PUP provided habitat for a diverse insect community and substantially increased the species richness of all insect functional (Figure 5) and taxonomic (WebFigure 1) groups. For example, there were, on average, approximately two and half times more pollinator and over three times more parasitoid species in the site when species in the PUP were taken into account (WebPanel 6). Likewise, there were, on average, three and a half times more beetle and one and a half more hemipteran bug species in the site when species in the PUP were taken into account (WebPanel 6). Taken together, our findings highlight the potential of PUPs to boost and sustain functionally and taxonomically diverse insect communities. In this case example such increases are likely a consequence of the supplementary food and habitat resources provided by the PUP's plant species, as well as increased vegetation complexity and proportion of native species.

'Grasslands' is an example of a pop-up park that supports fundamental advances in our understanding of the potential of small-scale, temporary urban greenspaces to provide biodiversity benefits. We should sound a note of caution, however, as our study has thrown up questions in need of further investigation. Most importantly, we lack the evidence to ascertain whether the insect species documented in the PUP: (1) colonised the temporary vegetation while dispersing from surrounding greenspace patches; (2) were actively attracted by the new resources provided by the PUP; or (3) were simply incubated outside the study site, tagging along with the soil and plants that were used to assemble the PUP. We are confident that our research will serve as a base for future studies looking to disentangle the mechanisms that enable PUPs to attract biodiversity to urban environments. We were unable to further assess whether some insect species might have been attracted initially to the PUP to eventually 'spill over' to the permanent vegetation, and therefore become part of the site's community once the temporary vegetation was removed. We are currently designing a follow-up field experiment to address this knowledge gap. Despite these limitations, the opportunities offered by the 'Grasslands' case study suggest that PUPs around the world are uniquely placed to contribute to our understanding of how to optimally design greenspaces to bring biodiversity back into our cities.

■ Potential social benefits of pop-up parks

Multiple threads of compelling evidence from epidemiological, experimental and survey studies have repeatedly substantiated the link between large, permanent greenspaces and a wide range of social benefits, including improvements in physical health and mental well-being, increased social contact and cohesion, improved child cognitive development, reduction of aggression, violence and crime, opportunities for education, and fostering and reforging connections with nature (Tzoulas *et al.* 2007; Hartig *et al.* 2014; Dadvand *et al.* 2015; Soga *et al.* 2016; Davern *et al.* 2017; Hand et al. 2017). Indeed, the provision of greenspace for positive social outcomes has underpinned the creation of large, permanent parks in the densest areas of cities since the 19th century (Hartig and Kahn 2016), with some early examples like the Alameda de Hércules (Seville, Spain) dating back to the 1500s. This reasoning now sits at the core of global sustainability initiatives such as the United Nation's Sustainable Development Goals (Griggs *et al.* 2013) and New Urban Agenda (UN 2017), and is guiding local government policy around the World (City of Melbourne 2017; ICLEI 2017).

An intriguing question remains about whether the social benefits linked to large, permanent greenspaces may also be provided by PUPs. Pop-up parks might be less likely, for example, to provide health benefits derived from physical activities such as walking and running, or those associated with long-term exposure to phytoncides and reduced air pollution. However, we suggest that PUPs may help people rekindle their connections with nature, socialise, spend time outdoors, and experience positive short-term body and mind states, including mental restoration and concentration. With an emphasis on the social interaction and mental restoration potential of PUPs, our attention is directed to evidence provided by small-scale, permanent greenspaces such as pocket parks. For instance, a groundbreaking study investigating the interactions between city-dwellers and nine pocket parks in a dense urban setting found that the primary reasons people visited the parks were for socialising and mental restitution (Peschardt *et al.* 2012). Related studies focusing on the design of pocket parks highlight the key role of particular design elements in stimulating social interactions and mental restoration, from varying the amount and arrangement of both natural (e.g. vegetation, flowers and water) and human-made (e.g. seating arrangements) elements (Nordh and Ostby 2013; Peschardt *et al.* 2016). Additionally, a recent study examining patterns of PUP use through a robust direct observation instrument showed that PUPs triggered beneficial changes in time-allocation patterns among users, including a reduction in screen-time and an increase in overall time spent outdoors (Salvo et al. 2017). We believe this the first, and thus far only, published work to provide empirical evidence of the social benefits of PUPs.

The question of how to best study the social benefits of PUPs remains to be fully explored. The instantaneous and short-term responses elicited by PUPs in people may require new methodological tools to complement or go beyond the physio- and psychological methods that have been traditionally used to assess responses to greenspace design (Chang *et al.* 2016; Wolf *et al*. 2017). An exciting alternative, and one that is currently being used to study the emotional states of urban residents in environmental psychology projects such as WeSense and Mappiness, would be to couple the experience-sampling method (Csikszentmihalyi and Larson 2014) with mobile technologies and social media information systems capable of collecting real-time, spatially-explicit data. Although financial and time limitations precluded us from using this methodology in the 'Grasslands' case study, we believe this novel approach has great potential for elucidating people's responses to PUPs through space and time.

■ Pop-up parks as socio-ecological laboratories

Pop-up parks could offer a controlled environment for studying many urban design questions that have, to date, seemed intractable. Pop-up parks can be considered as socio-ecological laboratories; unique testing grounds to conduct designed experiments capable of informing urban design (Felson *et al.* 2013). As illustrated by the 'Grasslands' case study, adding food and habitat resources can lead to quantifiable biodiversity outcomes, which may be used to inform evidence-based conservation actions in all urban greenspaces. Experimentally controlling design features and the duration and spatial configuration of PUPs will be particularly valuable for elucidating evidence of causal pathways and interactions between greenspace design and socio-ecological benefits.

We are now presented with an exciting opportunity for ecologists, social scientists and urban design and planning professionals to come together to identify an interdisciplinary research agenda for exploring the socio-ecological benefits of PUPs. As a starting point, we can seek to understand how PUPs can be used to build the evidence-base for biodiversity and social benefits derived directly from contact with nature in cities, to address the degree by which these benefits potentially differ from those in permanent greenspaces, and to explore particular design characteristics of PUPs that are most important for promoting benefits to humans and other species. Moreover, given that they are currently being considered as an alternative urban greening solution across a wide range of cities around the world, PUPs present a unique opportunity to test potential differences arising from dissimilar biogeographical and cultural contexts. Importantly, the synergies and trade-offs of designing for multiple, sometimes contrasting, objectives, and the impermanency of POPs could be deliberately assessed. By providing an experimental socio-ecological framework, PUPs offer a platform for addressing targeted research questions and resolving other key gaps in urban greenspace design.

■ Conclusions

PUPs are swiftly evolving into a global urban phenomenon, but the opportunity this provides to benefit biodiversity and people in cities remains unharnessed. In this paper, we have summarised current understanding of the socio-ecological benefits of PUPs and presented evidence that brings us closer to understanding the untapped potential of small-scale, short-lived greenspaces to deliver biodiversity benefits in densely-populated urban areas. In addition, we have highlighted the potential social benefits that PUPs may deliver to urban residents. Pop-up parks should not be considered substitutes for existing large, permanent greenspaces. Instead, we advocate for the synergistic role that small, temporary greenspaces can play in urban environments by proposing PUPs as an additional and complementary opportunity to bring nature back into cities. Given the rapid rate at which the world is urbanising, PUPs and other small-scale greenspaces provide important opportunities for people living in dense urban areas to engage with nature. Looking to the future, the question that remains to be fully explored is how best to design PUPs to meet this challenge.

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Panel 1. 'Grasslands' case study experimental design

Our study site was the forecourt green space of the State Library of Victoria, Melbourne, Australia (Figure 3). At the time of our study, the site's permanent vegetation was structured by a series of ornamental bed islands, which when taken together created a cover of approximately 100 m^2 of non-native plant species (WebPanel 4; Figure 3). These islands were interspersed among a 1,000 m^2 lawn, which was not included as part of the study. For six weeks during the Austral spring of 2014, a pop-up park called 'Grasslands' was placed amidst the site's permanent vegetation, overlaid on top of the library's forecourt steps (Figures 1c & 3). 'Grasslands' was the brainchild of artist Linda Tegg, who conceived it to recreate the native grasslands that used to be widespread throughout temperate southeastern Australia, using historical data found within the library. 'Grasslands' was distinctly modular, its basic units being 52 x 26.5 x 12 cm planter crates and 1/8 m^3 planter bags. In total, it was structured by 971 crates and 100 bags, providing a total vegetated area of 130 m^2 (Figure 3). Its plant community, which was grown in a greenhouse before being moved on site, included 56 native species, representing 25 families (WebPanel 4).

We collected insects and spiders from both the site's permanent and pop-up park vegetation across five consecutive weeks (Figure 3). We employed an entomological net (50 cm diameter), using five sweeps per each cubic metre of aboveground vegetation, therefore guaranteeing that survey effort was proportional to the vegetated volume. In order to minimise collector bias, all sweep-netting was conducted by a single researcher. Insect samples were sorted into morphospecies and identified to a level of taxonomical resolution that allowed each morphospecies to be assigned into: (1) functional groups, including pollinators, herbivores, predators, parasitoids and detritivores (Figure 4); and (2) taxonomic groups, including spiders (Araneae), beetles (Coleoptera), flies (Diptera), bugs (Hemiptera), ants, bees and wasps (Hymenoptera), and butterflies and moths (Lepidoptera). A full list of the insect and spider species observed during the study is provided in WebPanel 5. We used these data to build two datasets: one recording species site occupancy only at the site's permanent vegetation (henceforth *base*), and a second one recording species site occupancy at both the permanent and pop-up vegetation (henceforth *full*). In both cases, the weekly samples constituted the units of inference – that is, the temporal sample units in which we collected data to draw inferences on species site occupancy (Figure 3).

We analysed our data using a variation of the hierarchical community model provided by Mata et al. (2017). A key advantage of our modelling approach is that each species is treated as a random effect, therefore allowing for species richness to be estimated with its full associated posterior distribution (Kéry and Royle 2016). We conducted our analysis through the following four steps: (1) we analysed the *base* dataset to obtain a baseline species richness estimate for the whole community and each functional and taxonomical group – this is, the site's gamma diversity across the study period when only species observed in the permanent vegetation were considered (γ_{base}); (2) we analysed the *full* dataset to obtain combined species richness estimates – that is, the site's gamma diversity when species observed in both the permanent and pop-up vegetation were considered (γ_{full}); and (3) we compared the species richness posterior distributions for the whole community and each functional and taxonomical group estimated in (1) and (2) to assess the effect that the pop-up park had, if any, on the site's gamma diversity – our hypothesis being that $\gamma_{full} > \gamma_{base}$. As our data provided strong evidence to support this hypothesis, we proceeded then to (4) calculate the number of unique species contributed exclusively by the pop-up park during the duration of the 'Grasslands' installation. Findings are presented and discussed in the main text. In the web-only material we provide the full description of our statistical model and its Bayesian inference implementation (WebPanel 1), as well as the R scripts (WebPanel 2) and data (WebPanel 3) necessary to reproduce all analyses.

Figure legends

Figure 1. Three examples of pop-up parks. (a) A PARK(ing) Day pop-up park in Arlington, USA (Photo courtesy of County Environmental Services); (b) the RMIT University City Campus A'Beckett Urban Square pop-up park in Melbourne, Australia (Photo courtesy of John Gollings); and (c) the 'Grasslands' pop-up park in the forecourt greenspace of the State Library of Victoria, Melbourne, Australia (Photo courtesy of Matthew Stanton).

Figure 2. Location of pop-up parks occurring as part of Park(ing) Day 2013. Each green circle represents a pop-up park. Source: http://parkingday.org

Figure 3 (within Panel 1). Schematic representation of the 'Grasslands' case study experimental design. Within the study site we collected samples from the permanent and pop-up park vegetation during five consecutive weeks (Week 1: 23-Oct-14; Week 2: 30-Oct-4; Week 3: 7-Nov-14; Week 4: 12-Nov-14; Week 5: 23-Nov-14). This yielded ten samples, five each from the permanent (PVα1… PVα5) and pop-up park (PUPα1…PUPα5) vegetation, which we used to build a base (γ_{base}) and full (γ_{full}) datasets as described in the text.

Figure 4 (within Panel 1). Representative species or taxa of each insect functional group documented and studied as part of the 'Grasslands' pop-up park case study (from left to right): the pollinator hoverfly *Melangyna viridiceps*

(Macquart, 1847); the herbivorous lygaeid heteropteran bug *Nysius vinitor* Bergroth, 1891; the predaceous formicine ant *Nylanderia rosae* (Forel, 1902); a parasitoid pteromalid wasp; and the detritivorous lawn fly *Hydrellia tritici* Coquillett, 1903. All photos from the ‘Grasslands’ installation.

Figure 5. Estimated species richness occurring in the State Library of Victoria with (dark grey rectangles) and without (light grey rectangles) the contribution of the ‘Grasslands’ pop-up park for each insect functional group (Pol: pollinators; Her: herbivores; Pre: predators; Par: parasitoids; Det: detritivores) and for all groups combined. Black solid lines within each rectangle indicate the mean response. Rectangles represent the 95% Credible Interval associated with each mean response.

Web-only material

WebPanel 1. ‘Grassland’ case study: statistical model description and inference implementation

WebPanel 2. ‘Grassland’ case study: R software code script

WebPanel 3. ‘Grassland’ case study: dataset

WebPanel 4. ‘Grassland’ case study: plant species list

WebPanel 5. ‘Grassland’ case study: insect and spider species list

WebPanel 6. ‘Grassland’ case study: model species richness estimates

WebPanel 7. Extended acknowledgments

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WebFigure 1. Estimated species richness occurring in the State Library of Victoria with (dark grey rectangles) and without (light grey rectangles) the contribution of the 'Grasslands' pop-up park for each insect taxonomical group. Black solid lines within each rectangle indicate the mean response. Rectangles represent the 95% Credible Interval associated with each mean response.