ACSA Publications Listing
No. 18 – March 2022
List moderator: Amy Slocombe

Journal Articles - *Conference Proceedings Articles* *Dissertations* - *Books & Chapters*

From the moderator

Thank you to everyone who contributed to this issue of the ACSA Publications Listing.

The ACSA Publication Listing is a quarterly electronic listing of publications in the field of citizen science within the Australian community. The listing is intended to share information with those interested in the Australian citizen science community.

If you are interested in obtaining a copy of one of the papers below, you can email the lead author who may send you a copy at their discretion.

Amy Slocombe

Abstracts of recently published journal articles

Understanding citizen scientists' willingness to invest in, and advocate for, conservation

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Citizen science (CS) can be an effective means for achieving conservation outcomes while also generating a range of benefits to participants. According to functionalist theory, similar activities may serve distinct psychological functions in different people. To understand how benefits are generated, we must, therefore, gain insight into citizen scientists' motivations. A

question that has yet to be addressed, is the extent to which motivations and perceived benefits may affect participants' engagement and productivity. We surveyed participants in a diverse range of CS programmes in the South-east of England using a modification of the Volunteer Functions Inventory (VFI). We then linked variation in motivations and perceived benefits to participant-specific project outputs (effort and time invested) and outcomes (willingness to advocate for the cause).
Citizen scientists were most motivated by personally held values and by the opportunity to engage with nature. However, the relative importance of the various motivators differed significantly between programmes. Participants most commonly reported altruistic benefits, e.g. contributing to community needs. The strongest drivers of personal investment appeared to be social motivations and the desire to learn or share knowledge. Those motivated by personally held values and by knowledge were also more likely to advocate. The modified VFI offers a nuanced understanding of citizen scientists' motivations and lays the foundation for an evidence-based approach to designing, implementing and evaluating CS. However, the study offers but a snapshot, and longitudinal studies will be crucial to capture the dynamic relationship between motivations, benefits and the factors that drive engagement and retention.

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Nature-Based Citizen Science as a Mechanism to Improve Human Health in Urban Areas

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The world is becoming increasingly urbanised, impacting human interactions with natural environments (NEs). NEs take a number of forms, ranging from pristine, modified, to built NEs, which are common in many urban areas. NEs may include nature-based solutions, such as introducing nature elements and biological processes into cities that are used to solve problems created by urbanisation. Whilst urbanisation has negative impacts on human health, impacting mental and physical wellbeing through a number of mechanisms, exposure to NEs may improve human health and wellbeing. Here, we review the mechanisms by which health can be improved by exposure to NEs, as explained by Stress Reduction Theory, Attention Restoration Theory, and the ‘Old Friends’/biodiversity hypothesis. Such exposures may have physiological and immunological benefits, mediated through endocrine pathways and altered microbiota. Citizen Science, which often causes exposure to NEs and social activity, is being increasingly used to not only collect scientific data but also to engage individuals and communities. Despite being a named component of scientific and environmental strategies of governments, to our knowledge, the intrinsic health benefits of Citizen Science in NEs do not form part of public health policy. We contend that Citizen Science programs that facilitate

exposure to NEs in urban areas may represent an important public health policy advance.

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Quality Characteristics for User-Generated Content

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Today, vast amounts of data are collected from the internet, and the general public generates most data using social networks. There is a need to have a comprehensive approach to characterize the quality of such user-generated data collection from the internet. The data quality characteristics accepted among database and computer science communities have definitions that are not domainspecific. Therefore, there is no clear understanding of the data quality characteristics specific to user-generated content. This research examines different user-generated content platforms against the general data quality characteristics to determine which quality characteristics are essential for user-generated content. The research contributes to a list of definitions of those data quality characteristics specific to user-generated content. These definitions help identify quality characteristics useful for user-generated content platforms and their implementations. The quality of the content of Atlas of Living Australia, Twitter, YouTube, Wikipedia, and WalkingPaths is evaluated to assess the essence of the quality characteristics defined in this research.

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EchidnaCSI: Engaging the public in research and conservation of the short-beaked echidna

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The short-beaked echidna is an iconic Australian animal and the most-widespread native mammal, inhabiting diverse environments. The cryptic nature of echidnas has limited research into their ecology in most areas; however, from the well-researched and endangered Kangaroo Island echidna population, we understand that the threats include habitat loss, roads, and invasive species. To obtain more information about echidnas Australia-wide, we established

the Echidna Conservation Science Initiative (EchidnaCSI) citizen science project. EchidnaCSI calls on members of the public to submit photographs of wild echidnas and learn to identify and collect echidna scats for molecular analysis. To facilitate participation, we developed a smartphone application as well as ongoing social and traditional media activities and community events. In 3 y, more than 9,000 members of the public have downloaded the EchidnaCSI app, collecting 400 scats and submitting over 8,000 sightings of echidnas from across Australia. A subset of submitted scat samples were subjected to DNA extraction and PCR, which validated the approach of using citizen science for scat collection and viability for molecular analysis. To assess the impact of the project through public participation, we surveyed our participants (n = 944) to understand their demographics and motivations for engagement. Survey results also revealed that EchidnaCSI served as a gateway into citizen science more generally for many participants. EchidnaCSI demonstrates the potential for using citizen science approaches to collect high-quality data and material from a cryptic species over a very large geographic area and the considerable engagement value of citizen science research.

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A Citizen Science Community of Practice: Relational Patterns Contributing to Shared Practice

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Citizen science networks are a recent global phenomenon, with associated communities of practice that have emerged to support growth in the field and the development of practices. Effective communities of practice are dependent on the interactions from the social network underpinning the community. We examined the Australian citizen science practitioner network, using a combined social network analysis and survey approach. Our goal was to understand the structure and characteristics of this network, to establish who participates in this network, where and how interactions occur, and explore what participation achieves for the users. The Australian citizen science practitioner network has benefited from face-to-face citizen science events to make important connections that have been leveraged to benefit other working relationships and positive outcomes, especially for early-career practitioners and women within the network. How the community of practice continues to navigate successful knowledge exchange across society and science, whether through interactions in face-to-face or virtual settings, will need to be addressed as the community continues to grow in scope and size. In particular, the network will need to consider supporting key individuals who play important bridging functions across the citizen science practitioner network. The emergence of transdisciplinarity amongst those working in citizen science is a promising property of this learning community that is worth working strategically to maintain.

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COVID restrictions impact wildlife monitoring in Australia

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The global COVID-19 pandemic has imposed restrictions on people's movement, work and access to places at multiple international, national and sub-national scales. We need a better understanding of how the varied restrictions have impacted wildlife monitoring as gaps in data continuity caused by these disruptions may limit future data use and analysis.
To assess the effect of different levels of COVID-19 restrictions on both citizen science and traditional wildlife monitoring, we analyse observational records of a widespread and iconic monotreme, the Australian short-beaked echidna (*Tachyglossus aculeatus*), in three states of Australia. We compare citizen science to observations from biodiversity data repositories across the three states by analysing numbers of observations, coverage in protected areas, and geographic distribution using an index of remoteness and accessibility. We analyse the effect of restriction levels by comparing these data from each restriction level in 2020 with corresponding periods in 2018–2019.
Our results indicate that stricter and longer restrictions reduced numbers of scientific observations while citizen science showed few effects, though there is much variation due to differences in restriction levels in each state. Geographic distribution and coverage of protected and non-protected areas were also reduced for scientific monitoring while citizen science observations were little affected.
This study shows that citizen science can continue to record accurate and widely distributed species observational data, despite pandemic restrictions, and thus demonstrates the potential value of citizen science to other researchers who require reliable data during periods of disruption.

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Using citizen science to test for acoustic niche partitioning in frogs

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The acoustic niche hypothesis proposes that to avoid interference with breeding signals, vocal species should evolve to partition acoustic space, minimising similarity with co-occurring

signals. Tests of the acoustic niche hypothesis are typically conducted using a single assemblage, with mixed outcomes, but if the process is evolutionarily important, a pattern of reduced acoustic competition should emerge, on average, over many communities. Using a continental-scale dataset derived from audio recordings collected by citizen scientists, we show that frogs do partition acoustic space. Differences in calls were predominately caused by differences in spectral, rather than temporal, features. Specifically, the 90% frequency bandwidths of observed frog assemblages overlapped less than expected, and there was greater distance between dominant frequencies than expected. To our knowledge, this study is the first to use null models to test for acoustic niche partitioning over a large geographic scale.

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Tag Frequency Difference: Rapid estimation of image set relevance for species occurrence data using general-purpose image classifiers

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iEcology is used to supplement traditional ecological data by sourcing large quantities of media from the internet. Images and their metadata are widely available online and can provide information on species occurrence, behaviour and visible traits. However, this data is inherently noisy and data quality varies significantly between sources. Many iEcology studies utilise data from a single source for simplicity and efficiency. Hence, a tool to compare the suitability of different media sources in addressing a particular research question is needed.

We provide a simple, novel way to estimate the fraction of images within multiple unverified datasets that potentially depict a specified target fauna. Our method, the Sum of Tag Frequency Differences (STFD), uses any pretrained, general-purpose image classifier. One of the method's innovations is that it does not require training the classifier to recognise the target fauna. Instead, STFD analyses the frequency of the generic text-tags returned by a classifier for multiple datasets and compares them to the corresponding frequencies of an authoritative image dataset that depicts only the target organism. From this comparison, STFD allows us to deduce the fraction of images of the target in unverified datasets.

To validate the STFD approach, we processed images from five sources: Flickr, iNaturalist, Instagram, Reddit and Twitter. For each media source, we conducted an STFD analysis of three fauna invasive to Australia: Cane toads (Rhinella marina), German wasps (Vespula germanica), and the higher-level colloquial taxonomic classification, “wild rabbits”. We found the STFD provided an accurate assessment of image source relevance across all data sources and target organisms. This was demonstrated by the consistent, very strong correlation (toads $r \geq 0.97$, wasps $r \geq 0.95$, wild rabbits≥ 0.95) between STFD predictions, and the fraction of target images in a source dataset observed by a human expert.

The STFD provides a low-cost, simple and accurate comparison of the relevance of online image sources to specific fauna for iEcology applications. It does not require expertise in machine learning or training neural-network species-specific classifiers. The method enables researchers to assess multiple image sources to select those warranting detailed investigation for the development of tools for web-scraping, citizen science campaigns, further monitoring or analysis.

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Citizen science reveals current distribution, predicted habitat suitability and resource requirements of the introduced African Carder Bee *Pseudoanthidium* (*Immanthidium*) repetitum in Australia

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The introduction of non-native bee species is a major driver of ecosystem change resulting in the spread of non-native weeds, alterations to plant-pollinator interactions and competition with native species for food and nesting resources. Our lack of ecological information for many non-native organisms hinders our ability to understand the impacts of species introductions. This is often compounded by the Wallacean Shortfall—a lack of adequate knowledge of a species' distribution in geographic space. In Australia, the African carder bee (Pseudoanthidium (Immanthidium) repetitum) was first observed in 2000 and has since become one of the most common bees in some regions. Despite its rapid population increase and range expansion, little is known about the ecology or distribution of P. repetitum. In this study, we determine the flower preferences, current distribution and predicted areas at risk of future invasion of P. repetitum using opportunistic data collected from citizen science websites, social media and museum records. We found that the current distribution of P. repetitum in Australia encompasses approximately 332,000 km2 concentrated along the eastern coast. We found considerable suitable habitat outside the current distribution including biodiversity hotspots and world heritage listed natural areas. Pseudoanthidium repetitum foraged on a wide range of plants from many families and can thus be classified as a generalist forager (polylectic). Our results suggest that P. repetitum is well suited for continued expansion in coastal Australia. Our results demonstrate the effective application of opportunistic data in overcoming knowledge gaps in species ecology and modelling of introduced species distribution.

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Methodological Diversity in Citizen Science Mosquito Surveillance: A Scoping Review

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Global concern regarding mosquito-borne disease emergence and re-emergence has driven the development of citizen science mosquito surveillance initiatives. Although these initiatives have shown great potential to assist local health authorities, ensuring outcomes are translatable to improved public health policy and practice remains challenging. Here we present a summary of citizen science mosquito surveillance programs worldwide, their focus, strategies, and outcomes, with a view to how best to apply this approach in their local areas. A scoping review of studies and reports was conducted through systematic search on electronic databases (Scopus, PubMed, Web of Science, and Google Scholar), grey literature, and other documents listed in the references of selected articles. A total of 33 citizen science studies included in this review described 29 citizen science mosquito surveillance projects operating in 16 countries, besides three programs with wide geographic coverage. The selected programs focused on different strategies and methods according to their local and national contextual needs. The majority of the programs reported being free or low in cost, and amenable to participants. Also, citizen scientists valued the opportunity to actively contribute to a scientific activity in which they saw value. Local and national programs have been successful in involving the broader public and yielding data on mosquito populations. However, to ensure the best public health outcomes, sustainability, and scalability, there is a need to continue engaging with stakeholders, including community members, researchers, public health agents, industry, and policymakers, and to bridge existing collaborations across different sectors.

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Facilitating Conservation Progress

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Promoting insect conservation in Australia depends on wider appreciation of insect variety, importance and vulnerability, and that their conservation cannot be pursued comprehensively by professional scientists alone, or by the current financial and other logistic resources available, or that are likely to become available. Continually increased interest and appreciation from the wider populace, including young people, is a key component of rendering insect conservation both socially acceptable and potentially successful. Examples of 'citizen science' involvement in insect surveys and related conservation activities have already done much to increase and stimulate conservation in Australia, with attention both to diversity and individual 'flagship' species major contributions toward that objective. They are discussed in the context of increasing awareness of insect diversity and understanding the richness and vulnerability of

numerous native taxa and their restricted environments, whilst acknowledging that information on insect richness and ecology is still far from complete.

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Is conscientious beachcombing the key to 'unlock' marine plastic pollution trends through citizen science? A case study from Cockburn Sound, Western Australia

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Despite the global implementation of plastic waste reduction policies and bans on single use plastics (SuPs), their effectiveness for protecting marine ecosystems remains unclear. Frequent monitoring could confirm policy effectiveness, but this is difficult due to resourcing and logistic constraints. This study tested a 'beach litter' beachcombing citizen science approach that could overcome some constraints. Between November 2018 and January 2021, 168 beach visits led to the collection of 12,659 pieces of litter from a beach in Western Australia. Litter was predominantly plastic (87%) and mostly associated with fishing/boating (34%). Significant reductions in six types of litter, including fishing/boating items, balloons, and straws were detected and four coincided with local government waste mitigation measures. We show potential to harness conscientious beachcombers as citizen scientists to help evaluate plastic policy impact. Furthermore, we propose how to harness this effort and increase spatial and temporal coverage of marine plastic pollution monitoring.

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Many cameras make light work: opportunistic photographs of rare species in iNaturalist complement structured surveys of reef fish to better understand species richness

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Citizen science is on the rise, with growing numbers of initiatives, participants and increasing interest from the broader scientific community. iNaturalist is an example of a successful citizen science platform that enables users to opportunistically capture and share biodiversity

observations. Understanding how data from such opportunistic citizen science platforms compare with and complement data from structured surveys will improve their use in future biodiversity research. We compared the opportunistic fish photographs from iNaturalist to those obtained from structured surveys at eight study reefs in Sydney, Australia over twelve years. iNaturalist recorded 1.2 to 5.5 times more fish species than structured surveys resulting in significantly greater annual species richness at half of the reefs, with the remainder showing no significant difference. iNaturalist likely recorded more species due to having simple methods, which allowed for broad participation with substantially more iNaturalist observation events (e.g., dives) than structured surveys over the same period. These results demonstrate the value of opportunistic citizen science platforms for documenting fish species richness, particularly where access and use of the marine environment is common and communities have the time and resources for expensive recreational activities (i.e., underwater photography). The datasets also recorded different species composition with iNaturalist recording many rare, less abundant, or cryptic species while the structured surveys captured many common and abundant species. These results suggest that integrating data from both opportunistic and structured data sources is likely to have the best outcome for future biodiversity monitoring and conservation activities.

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