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

Opportunistic sightings of blue whales off Sydney, Australia

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Two subspecies of blue whale occur in Australian waters, (1) the pygmy blue whale (*Balaenoptera musculus brevicauda*) and (2) the Antarctic blue whale (*Balaenoptera musculus intermedia*). Understanding blue whale presence in Australian waters is critical to ensuring Australia's protection of these marine mammals as both subspecies were heavily exploited during historical whaling. This short note documents pygmy blue whale sightings in New South Wales waters over the last 18 years. Observations were opportunistically made via citizen science and verified by scientists. Sightings in this note contribute to our limited knowledge of pygmy blue whale distribution along the east coast of Australia and may help understand the

migratory movements of New Zealand pygmy blue whales off Australia and in the Tasman Sea. Overall, information presented in this note contributes to Australia's national and international conservation efforts to protecting blue whales as a migratory and threatened species.

Citizen science project characteristics: Connection to participants' gains in knowledge and skills

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Background: Biodiversity is being lost rapidly and its conservation is thus one of the most urgent tasks today. For biodiversity conservation to be successful, the public needs to gain an awareness and understanding of biodiversity and its importance. Moreover, species experts are needed who have the skills necessary for identifying and recording biodiversity. Previous research showed that citizen science projects can contribute to educating the public about biodiversity. However, it is still unclear how project characteristics connect to participants' knowledge and skills and how citizen science projects should be designed if they are to foster participants' learning.

Aim: We aimed to investigate specific characteristics of biodiversity citizen science projects that could potentially influence participants' learning. We explored the following project characteristics from both the project coordinators' and the participants' perspectives: information and training provided to participants, social interaction among participants, contact between participants and staff, and feedback and recognition provided to participants.

Methods and results: In order to examine the extent to which these project characteristics are connected to participants' gains in knowledge and skills, we conducted a comprehensive study across 48 biodiversity citizen science projects in Europe and Australia. We found that participants' perceived gains in knowledge and skills were significantly related to the five project characteristics as reported by the participants: information received by the participants, training received by the participants, social interaction among participants, contact between participants and staff, and feedback and recognition received by the participants.

Conclusion: We conclude that by deliberately designing citizen science projects to include features such as interaction and feedback, these projects could achieve higher learning outcomes for the participants. Thereby, suitable modes of communication between projects and their participants are crucial. We provide specific suggestions for the design of biodiversity citizen science projects and for future research on project characteristics and participant outcomes.

A Comprehensive Overview of Technologies for Species and Habitat Monitoring and Conservation

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The range of technologies currently used in biodiversity conservation is staggering, with innovative uses often adopted from other disciplines and being trialed in the field. We provide the first comprehensive overview of the current (2020) landscape of conservation technology, encompassing technologies for monitoring wildlife and habitats, as well as for on-the-ground conservation management (e.g., fighting illegal activities). We cover both established technologies (routinely deployed in conservation, backed by substantial field experience and scientific literature) and novel technologies or technology applications (typically at trial stage, only recently used in conservation), providing examples of conservation applications for both types. We describe technologies that deploy sensors that are fixed or portable, attached to vehicles (terrestrial, aquatic, or airborne) or to animals (biologging), complemented with a section on wildlife tracking. The last two sections cover actuators and computing (including web platforms, algorithms, and artificial intelligence).

Volunteer tourists as scientifically aware environmental citizens: citizen science within an Australian non-governmental organization

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It has been suggested that volunteer tourists (voluntourists) contribute to society in a variety of ways, although enthusiasm for such voluntourism is often tempered with an awareness of potentially less positive impacts. This article focuses on citizen-science conducted by voluntourists in an Australian conservation park, showing that such voluntourist-conducted conservation research is valued by participants, though challenges are identified, not least regarding the differing perceptions and expectations of the tours on offer. This is also potentially complicated by the often overlapping volunteer, tourist and researcher experiences, activities and identities. This study introduces a tentative typology of citizen-science activities that emerged during ethnographic fieldwork to help explore the voluntourists' engagement with

citizen-science projects and their implications for broader citizenship awareness and behaviour.

A bibliometric content analysis of do-it-yourself (DIY) science: where to from here for management research?

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Do-it-yourself (DIY) science research is currently in an expansion phase both in terms of its depth (with an increasing number of papers published each year) and its scope (with the core ideas being linked to an increasing number of constructs). To develop a more holistic appreciation of how the field has developed and to identify potential avenues of future research we undertake a bibliometric content analysis of the DIY science literature post 1980. We find four major clusters pertaining to education, culture, the operationalising of DIY science (including commercialisation) and technology-related issues. We review each of these clusters and the main themes contained within the cluster, including highlighting possible research questions that align to these key themes. We find the field to be highly dispersed theoretically on the basis of the bibliometric content analysis. In considering a range of sample papers in each thematic cluster, we identify a range of potential research topics going forward. Identifying the key thematic foci of DIY science research to date provides the researchers within the field the opportunity to clearly locate their work within a highly diverse literature and to build new research trajectories around core concepts.

Enhancing repository fungal data for biogeographic analyses

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Open-access occurrence data are useful for studying spatial patterns of fungi, but often have quality issues. These include errors in taxonomy and geo-coordinates, and incomplete coverage across areas and taxonomic groups. We identify 15 quality issues that can lead to incorrect biogeographic inference, and develop a reproducible pipeline that flags and removes problematic entries. This pipeline tests accuracy of geographic records and names. Then, if

information on non-native status is unavailable or unreliable, it detects non-native species via a predictive model. Finally, it identifies spatial and environmental outliers and removes them when biologically improbable. We test the pipeline by cleaning data for Australian fungi, with 251,642 records retained after cleaning the initial 1,034,601 records. Exploratory analysis showed that the cleaned data is useful for analyses such as biogeographic regionalisation, but recording gaps and lack of saturation in collection effort also caution that more surveys are needed to improve collection completeness.

Rebuilding relationships on coral reefs: Coral bleaching knowledge-sharing to aid adaptation planning for reef users

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Coral bleaching has impacted reefs worldwide and the predictions of near-annual bleaching from over two decades ago have now been realized. While technology currently provides the means to predict large-scale bleaching, predicting reef-scale and within-reef patterns in real-time for all reef users is limited. In 2020, heat stress across the Great Barrier Reef underpinned the region's third bleaching event in 5 years. Here we review the heterogeneous emergence of bleaching across Heron Island reef habitats and discuss the oceanographic drivers that underpinned variable bleaching emergence. We do so as a case study to highlight how reef end-user groups who engage with coral reefs in different ways require targeted guidance for how, and when, to alter their use of coral reefs in response to bleaching events. Our case study of coral bleaching emergence demonstrates how within-reef scale nowcasting of coral bleaching could aid the development of accessible and equitable bleaching response strategies on coral reefs. Also see the video abstract here: https://youtu.be/N9Tgb8N-vN0

Field measurements of a massive Porites coral at Goolboodi (Orpheus Island), Great Barrier Reef

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An exceptionally large coral Porites sp. has been identified and measured at Goolboodi (Orpheus Island), Great Barrier Reef (GBR). This coral was measured in March 2021 during citizen science research of coral reefs in the Palm Islands group. We conducted a literature review and consulted scientists to compare the size, age and health of the Porites with others in the GBR and internationally. This is the largest diameter Porites coral measured by scientists and the sixth highest coral measured in the GBR. The health of the Porites was assessed as very good with over 70% live coral cover and minor percentages of sponge, live coral rock and macroalgae. An estimated age of 421–438 years was calculated based on linear growth models. Manbarra Traditional Owners were consulted and suggested that the Porites be named Muga dhambi (big coral) to communicate traditional knowledge, language and culture to indigenous, tourists, scientists and students.

Naturally-detached fragments of the endangered seagrass *Posidonia australis* collected by citizen scientists can be used to successfully restore fragmented meadows

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Posidonia australis is a slow-growing seagrass that forms extensive meadows in sheltered coastal locations which are often popular areas for recreational boating. Traditional block-and-chain boat moorings can directly impact P. australis meadows, with the action of heavy chains eroding the seafloor and creating bare sand scars that fragment meadows. The installation of new environmentally friendly moorings (EFMs) can reduce damage to seagrasses, but natural re-establishment by P. australis to scars can be very slow. Given the endangered status of this species in New South Wales, Australia, we developed an innovative restoration procedure to

re-establish P. australis transplants within old scars without damaging existing meadows. Naturally-detached rhizome fragments were collected from the shore by citizen-scientists, stored within aquaculture tanks and then planted underwater. We planted a total of 863 fragments into six mooring scars at three different times. Survival of fragments after one year was significantly greater for those planted in June (54%) than in January (31%). The planting techniques (with or without natural fibre mats to stabilize sediments) and environmental conditions (surrounding habitat, depth and presence of the EFM) did not influence survival. Many surviving fragments (36.3%) had produced new shoots during the year. Our results show that naturally-detached seagrass fragments can be used to effectively restore P. australis meadows. This is an important new approach for supplying propagules for restoration without damaging remaining populations of an endangered seagrass, and presents a compelling management approach that engages local communities and enhances conservation efforts.

A standardised method for estimating the level of visible debris in bird nests

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Unlike records of plastic ingestion and entanglement in seabirds which date back to the 1960s, the literature regarding debris in bird nests is comparatively limited. It is important to identify standardised methods early so that data are collected in a consistent manner, ensuring that future studies can be comparable. Here, we outline a method that can be applied to photographs for estimating the proportion of visible debris at the surface of a nest. This method uses ImageJ software to superimpose a grid onto a photograph of a nest/s. The number of cells with and without debris are then counted. Our proposed method is repeatable, straightforward, and accessible. We optimised the method to estimate the level of visible debris in Northern Gannet (Morus bassanus) nests, however, with some modification (i.e., adjustment of grid cell size), it could be applied to other seabird species, and terrestrial birds, that incorporate debris within nests.

Contours of citizen science: a vignette study

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Citizen science has expanded rapidly over the past decades. Yet, defining citizen science and its boundaries remained a challenge, and this is reflected in the literature—for example in the proliferation of typologies and definitions. There is a need for identifying areas of agreement and disagreement within the citizen science practitioners community on what should be considered as citizen science activity. This paper describes the development and results of a survey that examined this issue, through the use of vignettes—short case descriptions that describe an activity, while asking the respondents to rate the activity on a scale from 'not citizen science' (0%) to 'citizen science' (100%). The survey included 50 vignettes, of which five were developed as clear cases of not-citizen science activities, five as widely accepted citizen science activities and the others addressing 10 factors and 61 sub-factors that can lead to controversy about an activity. The survey has attracted 333 respondents, who provided over 5100 ratings. The analysis demonstrates the plurality of understanding of what citizen science is and calls for an open understanding of what activities are included in the field.

Exploring the potential of citizen science for public health through an alcohol advertising case study

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Citizen science connects academic researchers with the public through combined efforts in scientific inquiry. The importance of involving impacted populations in health research is well established. However, how to achieve meaningful participation and the methodological impact of citizen science needs further examination. We examined the feasibility of using citizen science to understand the impact of alcohol advertising on Australian women through a breast cancer prevention project. Two hundred and eighty-two ('participants') citizen scientists completed demographic and behavioural questions via an online survey. The research participants moved into the role of citizen scientists by completing the data collection tasks of capturing and classifying images of alcohol advertising they saw online. Interrater reliability tests found high levels of agreement between citizen scientists and academic researchers with the classification of alcohol advertising brand (Kappa = 0.964, p < 0.001) and image type (Kappa = 0.936, p < 0.000). The citizen scientists were women aged 18 and over, with 62% between 35 and 55 years old. The majority were from major cities (78%), had attained a

bachelor's degree or higher-level education (62%) and were recruited via email or Facebook (86%). The use of citizen science provided methodological gains through the creation of a unique dataset with higher levels of validity than the existing literature, which employed traditional investigator-driven research methodologies. Citizen science enriched the dataset and provided a powerful methodological vehicle to understand an environmental determinant of health. The study illuminates how public participation benefitted the research process, the challenges and the potential for citizen science to improve public health.

Using citizen science to measure recolonisation of birds after the Australian 2019–2020 mega-fires

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Large and severe fires ('mega-fires') are increasing in frequency across the globe, often pushing into ecosystems that have previously had very long fire return intervals. The 2019–2020 Australian bushfire season was one of the most catastrophic fire events on record. Almost 19 million hectares were burnt across the continent displacing and killing unprecedented numbers of native fauna, including bird species. Some bird species are known to thrive in post-fire environments, while others may be absent for an extended period from the firegrounds until there is sufficient ecosystem recovery. To test for systematic patterns in species use of the post-fire environment, we combined citizen science data from eBird with data on sedentism, body size, range size and the specialisation of diet and habitat. Using generalised additive models, we modelled the responses of 76 bird species to the 2019–2020 Australian mega-fires. Twenty-two species decreased in occurrence after the fire; 30 species increased; and no significant effect was found for the remaining 24 species. Furthermore, diet specialists, and birds with smaller body sizes and range sizes were less likely to be found in burnt areas after the fire event compared to before, a result which generates testable hypotheses for recovery from other mega-fires across the globe. Being displaced from the firegrounds for an event of this geographic magnitude may have severe consequences for population dynamics and thus warrant considerable conservation attention in pre-fire planning and in the post-fire aftermath.

Drain Detectives: Lessons Learned from Citizen Science Monitoring of Beach Drains

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Stormwater drains are common features at city beaches. Stormwater impact from drains is well understood, but the extent and impact of dry-weather flows on water quality and therefore on swimmers is not. Traditional beach monitoring may not be sensitive or frequent enough to assess this risk from drains, and investigation of dry-weather pollution is limited by relatively slow turnaround times for laboratory analysis. This case study describes lessons learned from a trial of citizen science and water quality sensors to monitor drains for dry-weather flows. This involved the use of smartphones and data-collection platforms for community monitoring at signed drains and by trained citizen scientists. Monitoring consisted of photos, observations, and water sampling. A key lesson from the trial was how citizen science can enhance data collected by sensors or by traditional monitoring. Citizen scientists collected data that sensors could not provide on flows, such as size and colour at outlets, and whether flows reached the bay. When combined with sensor data, drains were risk profiled, with higher-risk drains investigated further. Another lesson learned was to adequately resource in-person engagement and communications to motivate and retain citizen scientists. Underestimating resources for engagement translated into less data collected. Community data from signs was a valuable addition, but could have been maximised by simplifying data collection and ensuring signs were close to where observations or photos needed to be taken. The approaches trialled and lessons learned from this project are informative for the design and delivery of similar projects.

Estimating koala density from incidental koala sightings in South-East Queensland, Australia (1997–2013), using a self-exciting spatio-temporal point process model

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The koala, Phascolarctos cinereus, is an iconic Australian wildlife species facing a rapid decline in South-East Queensland (SEQLD). For conservation planning, the ability to estimate the size of koala populations is crucial. Systematic surveys are the most common approach to estimate koala populations but because of their cost they are often restricted to small geographic areas and are conducted infrequently. Public interest and participation in the collection of koala sighting data is increasing in popularity, but such data are generally not used for population estimation. We modeled monthly sightings of koalas reported by members of the public from 1997 to 2013 in SEQLD by developing a self-exciting spatio-temporal point process model. This allowed us to account for characteristics that are associated with koala presence (which

vary over both space and time) while accounting for detection bias in the koala sighting process and addressing spatial clustering of observations. The density of koalas varied spatially due to the heterogeneous nature of koala habitat in SEQLD, with a mean density of 0.0019 koalas per km2 over the study period. The percentage of land areas with very low densities (0–0.0005 koalas per km2) remained similar throughout the study period representing, on average, 66% of the total study area. The approach described in this paper provides a useful starting point to allow greater use to be made of incidental koala sighting data. We propose that the model presented here could be used to combine systematic koala survey data (which is spatially restricted, but more precise) with koala sighting data (which is incidental and often biased by nature, but often collected over large geographical areas). Our approach could also be adopted for modeling the density of other wildlife species where data is collected in the same manner.

'First Known Photographs of Living Specimens': the power of iNaturalist for recording rare tropical butterflies

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Insects are the most biodiverse multicellular organisms, with most of this diversity in the tropics. Butterflies follow the same pattern, with ~ 90% of species from the tropics. Anthropogenic stressors such as habitat loss and pollution are driving butterfly declines globally, with many rare tropical species likely extinct before discovery. Citizen science is a powerful tool for supplementing professional monitoring of tropical butterfly biodiversity and better understanding butterfly biogeography, especially in remote regions or on private land. We created a 'project' on the online biodiversity citizen science platform iNaturalist to collect the first known photographs of rare taxa. Almost 20% of the project's records are butterflies, with observations of 406 butterflies for which the uploaded images are the first known photographs of living specimens. Over 90% of these are from the tropics, with Indonesia, Brazil and Peru the most-represented countries, and Theclinae, Riodininae and Satyrinae the most observed subfamilies. The project's success has been driven by a strong synergistic community of experts and amateur naturalists from around the globe that facilitates real-time discussions and the identification of rare and undescribed taxa.