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Science communication is integral to attracting widespread participation in bushfire recovery citizen science

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The 2019/20 bushfire season was a catastrophic event affecting large areas of Australia. Due to the devastating impact on biodiversity, the Australian public wanted to contribute towards assessing the impact of this disaster. To address this, three citizen science projects were established to engage citizen scientists in various aspects of environmental recovery. The projects offered different ways of participating, ranging from online, through to community field events, including those requiring specialised localised knowledge. As a result, communication approaches targeting different audiences were required. Here, we detail the communication strategies employed to promote and engage a diverse national and global audience in bushfire recovery projects. We provide metrics and analysis on how and where we promoted projects, including a breakdown of participation numbers for each project. We detail lessons learnt, and how we would improve our communication approach for future disaster recovery events to increase awareness at a community level and more broadly. Despite numerous challenges, including organising public-facing events during a global pandemic, the program serves as an exemplar of how to successfully partner with communities, research teams and government to enable citizen scientists to make meaningful, valuable and timely contributions to research. Ultimately, the program enabled widespread community involvement in bushfire recovery and filled gaps in baseline and post-fire data.

KEYWORDS

citizen science, communities, disaster & climate risk reduction, bushfire recovery, co-production

Introduction

The 2019/20 bushfire season was a catastrophic event affecting large areas of Australia, with a total area of between 7–10 million ha of the national landscape burned (Gallagher et al., 2021; Auld et al., 2022). Some areas throughout the south-east were particularly impacted, such as South Australia's Kangaroo Island where almost half the island burned (Bonney et al., 2020). Fires of the magnitude experienced during this spring and summer period were unprecedented for present-day climatic conditions (Nolan et al., 2020), with the impact on biodiversity widespread and well documented (Ward et al., 2020; Dickman, 2021). The fires had a huge emotional impact on people both within Australia (Filkov et al., 2020) and globally, eliciting strong responses from communities wanting to help and contribute to recovery where possible. Citizen science for disaster risk reduction and recovery holds huge

potential and has already demonstrated success in advancing knowledge, providing early warning and contributing to post-disaster monitoring and management (Hicks et al., 2019).

Citizen science targeted at bushfire monitoring is one mechanism to engage communities directly in both the science (Rowley et al., 2020; Kirchhoff et al., 2021) and also to build community resilience (Chari et al., 2019). It presents opportunities to engage in the science of recovery *via* a number of mechanisms, but is most widely applied in collecting postfire data (Kirchhoff et al., 2021). Scientific benefits of engaging in citizen science include the ability to collect post-fire data across areas typically inaccessible to professional scientists (i.e., private land) and the ability to collect data at large temporal and spatial scales (Chandler et al., 2017; Roger and Motion, 2022). This can be particularly relevant when travel or site access is limited due to hazardous conditions or restricted travel conditions (i.e., COVID-19 pandemic). With federal and state-based recovery actions being prioritised and monitoring programs developed across bushfire regions, an opportunity arose to build a program that engaged citizen scientists in the environmental monitoring of recovery and aligned with government priorities. As a result, three citizen science projects were co-designed with government to engage communities in various aspects of environmental recovery and help fill identified knowledge gaps.

Bushfire citizen science program

The program of work was a collaboration between the Australian Commonwealth Government Department of Climate Change, Energy, the Environment and Water (formerly the Department of Agriculture, Water and Environment) and the Atlas of Living Australia which is hosted by CSIRO. The Atlas of Living Australia (ALA) administered the program and partnered internally with CSIRO's National Research Collections Australia and externally with the University of New South Wales and Western Sydney University to run the three targeted projects.

Project 1: Big Bushfire BioBlitz

The purpose of the bioblitzes was to generate new evidence on the impacts of large-scale fire on biodiversity, and to support fire-affected communities to re-engage with nature and the science of recovery (Weill et al., 2020). The events took place over a 46-h period in spatially-adjacent burnt and unburnt areas in: The Greater Blue Mountains World Heritage Area (25–27 February 2022); forests of the NSW south coast (Murramarang National Park, 11–13 March 2022); and rainforests of the NSW North Coast and tablelands (6–8 May 2022). Locations were chosen based on accessibility, the support of park rangers and local area knowledge of trails and conditions. For bushfire impacted communities outside of the three locations listed above, the Big Bushfire BioBlitz project on the iNaturalist biodiversity platform was open to receive observations from citizen scientists from across Australia for the duration of the event series. Local and external experts, including researchers from the Centre for Ecosystem Sciences at UNSW, were invited to participate and provide their expertise at specific events. During each bioblitz, a number of structured surveys were conducted at planned times and at predetermined locations with each survey led by an expert or researcher and conducted with citizen participants. Participants were able to be autonomous and make observations independently of any planned surveys or expert-led walks and events, and at their own pace. All aspects of biodiversity (flora, fungi, fauna) were recorded, with all observations generated from the Big Bushfire BioBlitz open source and aggregated in the ALA biodiversity infrastructure from observations submitted to the iNaturalist, FrogID, and eBird biodiversity platforms.

Project 2: Flora connections

Flora Connections was designed to encourage flora groups to record post-fire recovery of priority plant species. The concept of this project was to draw on the expertise of active amateur botanists who have a strong connection to the plants in their local area to monitor and document priority plant species using a standardised method of recording how Australia's unique plants recover from fire. The project developed resources to help local flora groups record priority plant species observations using systematic data collection methods. A standardised method ensures decision-makers are confident to use the data in their assessments of bushfire impacts on flora (Boho et al., 2020). The first step involved creating an inventory of active flora groups throughout Australia. A survey data sheet was developed to include important information such as site and habitat information, species description, population numbers as well as disturbance and threats. A step-by-step guide was then prepared to help direct identified active flora groups through the established monitoring protocol. The guide explains the concept and aims of the project, how to record information and where to upload it. A website floraconnections. com was also developed as a resource for additional information and as a portal to submit data which is all open source on the Atlas of Living Australia. The website includes information on priority plants to help guide users in selecting which plant species to monitor. Priority plant species were selected based on a list of species (provided by the Commonwealth Government) that require assessment for 'threatened' status. Information on any of these plants may help secure funding for their future management and conservation (Auld et al., 2022). A survey 'light' version was created on the iNaturalist platform to encourage additional observations from people who were not able to commit to a systematic survey described in the methodology.

Project 3: Invertebrate digitisation

The Invertebrate Digitisation Project involved prioritising insect digitisation based on a list of priority invertebrate species requiring urgent management intervention or on-ground assessment, and was initiated post-bushfire by the federal Department of Climate Change, Energy, the Environment and Water (Department of Climate Change, Energy, the Environment and Water, 2021). This project was developed on the basis that there are over 8,000 specimens in CSIRO's National Research Collections Australia that are on the provisional list of priority invertebrate species. As such, the collection was identified as an invaluable resource in helping to inform their assessment. The goal of the project was to create a digitised and accessible historic insect data set that could help decision-makers prioritise invertebrate species for present day monitoring and intervention programs. Citizen

scientists were engaged in the transcription of specimen labels using the online DigiVol (https://digivol.ala.org.au/) platform run by the Australian Museum. Images were loaded onto the platform in batches of around 800 with each batch called an "expedition". Once transcribed and validated, the information was then loaded into the ALA, providing a permanent historical record of the occurrence of a species at a particular time and place.

Science communication

Science communication is increasingly being used as an integral tool with citizen science (Roger and Klistorner, 2016), and is crucial for promoting projects to engage participants, communicating results and project outcomes throughout the research process (Wagenknecht et al., 2021). Using science communication and citizen science as complementary approaches can help participants gain a shared understanding of the research process (Fischhoff, 2013). This becomes more crucial when participants in bushfire citizen science projects likely have a deeply rooted investment in understanding environmental recovery in their local area and how the science is being used to help inform management and policy decisions. Indeed, science communication is critical for highlighting community interest in contributing and participating post disaster event. Importantly, when science communication is performed well, it facilitates a two-way exchange of information, or knowledge co-production (Norström et al., 2020). Citizen science provides the mechanism to share this knowledge (Wagenknecht et al., 2021). Finally, a challenge for many citizen science projects is attracting participants and maintaining motivation throughout the life of a project. Therefore, science communication has an important role to play in the success of citizen science.

Here, we aim to demonstrate how we used best practice science communication to attract participants and promote the wider bushfire citizen science program more broadly. We provide metrics and analysis on how and where we promoted projects, including a breakdown of participation numbers for each project. We detail lessons learnt, and how we would improve our communication approach for future events to increase awareness at a community level and beyond. Our objective is to showcase how the reciprocal arrangement between citizen science and science communication can result in an exemplar of how to successfully partner with communities, research teams and government to enable meaningful and timely contributions to bushfire research.

Detail

The audience for this program was the Australian community as it was designed to respond to community interest and harness the power of citizen science for understanding bushfire recovery. To try and ensure inclusive engagement with the Australian public we adopted several whole-of-program tactics. The Federal Government partner launched the program with a Ministerial media release, which was amplified *via* CSIRO's media and social media channels. The launch was also supported with a promotional newsletter which was distributed to over 89,000 people (average open rate of 31%, 7.2% click through rate), and accompanied online blogs for both ALA and CSIRO channels describing the project (Figure 1). All three projects were listed on the Australian Citizen Science Association's Citizen Science Project Finder (ACSA, 2023) to increase discoverability.

Each project was promoted separately, depending on when individual projects were due to start, using a mix of communication platforms, e.g., radio, television news, media releases, blogs, newsletters, and social media (Figure 1). The communication tactics used were dependent on the project. For the bioblitzes, the widespread media campaign focused on eastern Australia due to the locations of the surveys (Figure 2). Events were promoted with a link to the registration page using local radio, and an ALA newsletter item. The University of New South Wales partner issued their own media release that was sent directly to media outlets servicing communities within geographical proximity of the events, resulting in 14 separate re-postings across online news sources. Organisers also spoke on local radio, again targeting areas impacted by the fires and in close temporal proximity to events. The events were also promoted on the ALA's Twitter account. During one of the bioblitz events, a survey with Gardening Australia's Costa Georgiadis (an Australian television personality) was livestreamed (Facebook). This engaged a broader cohort in the initiative and increased accessibility to the events for those unable to participate in person and attracted a wide audience on the social media platform Facebook (Figure 1). During the bioblitzes, community-level expertise was sought, as many participants were local and shared insights and knowledge about what they were observing on the day. As such, local knowledge was used to help inform identifications of the biodiversity recorded (Danielsen et al., 2018).

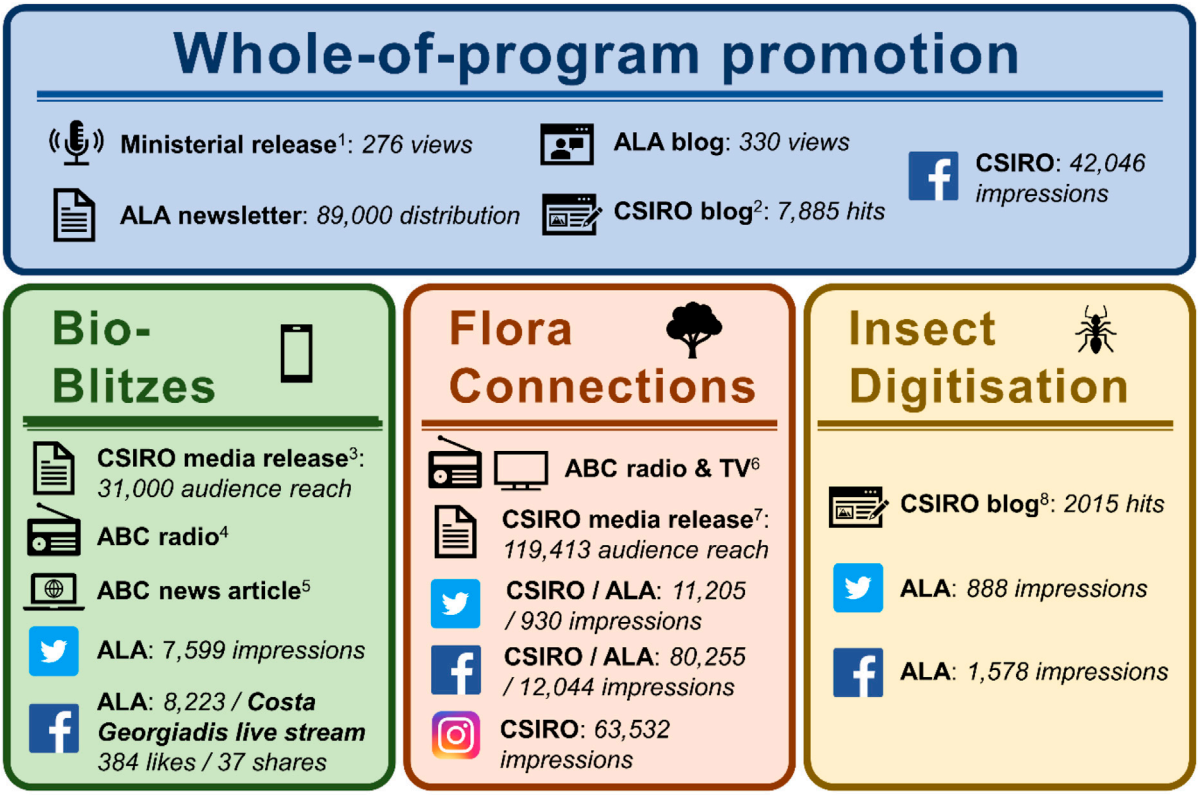
The Flora Connections Project was the most widely publicised project in terms of reach (Figure 1). CSIRO issued a media release when the project opened for participation, and further promoted through local radio and television, as well as sharing across CSIRO and ALA Twitter, Facebook and Instagram accounts (Figure 1). All media and social media directed towards the flora connections website where people could learn more about the project and submit data. Physical manuals were also mailed to various plant societies to encourage participation in the project and follow-up emails to all flora groups were sent.

The Insect Digitisation Project was promoted on a CSIRO blog and through ALA Twitter and Facebook postings. A blog was chosen as the preferred information dissemination pathway as it enabled direct linkages to the online project from the webpage and suited the broad (Australia-wide) audience targeted for this project. Findings and outcomes of all projects were reported directly *via* email to bioblitz participants and indirectly using online platforms, such as social posts and a webpage with a summary of project findings. It was also ensured that all data remained publicly available for all three projects *via* the ALA.

Results

Big Bushfire BioBlitzes

Over the three separate, 3-day-long events: 7,956 observations of species were made, representing 1,773 unique species. More than



Footnotes:
[1] https://www.csiro.au/en/news/News-releases/2021/Citizen-scientists-to-boost-bushfire-recovery-activities
[2] https://blog.csiro.au/big-bushfire-bioblitz/
[3] https://www.csiro.au/en/news/News-releases/2022/Citizen-scientists-help-record-impact-of-fires-on-biodiversity
[4] ABC Illawarra; ABC Mid North Coast; ABC Sydney (evenings)
[5] https://www.abc.net.au/news/2022-05-26/black-summer-bushfire-bioblitz-species-bounce-back/101099998
[6] ABC Sunshine Coast April; ABC South Coast; ABC Newcastle; ABC Melbourne
[7] https://www.csiro.au/en/news/News-releases/2022/Help-scientists-monitor-native-plants-after-extreme-weather-events
[8] https://blog.csiro.au/support-bushfire-science-from-home/
* Note ABC audience reach statistics were unavailable

FIGURE 1
Summary of the communication outreach and platforms used to promote the citizen science bushfire program.

535 people participated *via* both in-person and through online identification (Figure 2). There were over 200 event registrations for the first two events and 35 online registrations for the third event. Participants were not explicitly surveyed for demographic and background information, anecdotally it was found that the events attracted scientists, community amateur experts, government officials and interested members of the public across a wide range of ages.

Flora Connections

Twenty-seven complete surveys of nine different priority plant species have been completed for the Flora connections project at the time of writing. For the iNaturalist light-version, four people have participated, collectively contributing 18 observations of seven priority plant species. This project is still open for participation. Although participants were not explicitly surveyed for demographic and background information, anecdotally this project has attracted an even representation of genders with participants typically aged between 20–50 years.

Insect digitisation

Over the course of the project, more than 8,000 specimen images were digitised and loaded onto the ALA for specimen

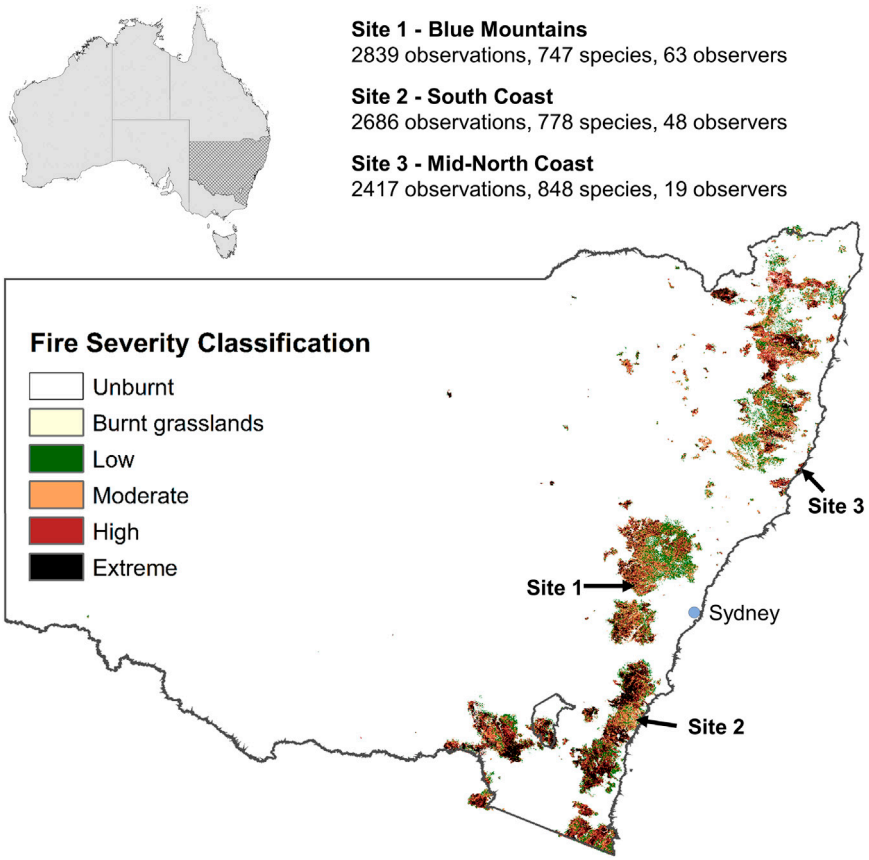


FIGURE 2
Big Bushfire BioBlitz locations overlayed against the 2019-2020 bushfire impact areas in NSW Australia. Total number of species observations, species and observers are provided for each bioblitz. Base maps were made using ArcGIS Desktop 10.7.1. The fire map layer was made using "Fire Extent and Severity Mapping (FESM) 2019/20" ESRI file, available from the NSW Department of Planning and Environment—SEED The Central Resource for Sharing and Enabling Environmental Data in NSW.

label transcription (Figure 3). Although eastern Australia was not targeted for this work, given that it was online and open to anyone, the majority of online participants were from the eastern states and territories of Australia (Figure 3). A total of 258 citizen scientists participated in the online label transcription, with 27 serving to help validate and check the metadata from this work. We do not have project specific participant information, however, a report prepared for the DigiVol platform found that the majority of volunteers on the site were female (70%), the youngest participant was 12 years of age and the oldest 90, with the majority (43%) aged between 61 and 75 years (Haski-Leventhal and Alony, 2021). Many participants were motivated to join DigiVol because of the online convenience and flexibility online volunteering affords (Haski-Leventhal and Alony, 2021).

Discussion

Citizen science and science communication have complementary roles in bushfire recovery citizen science to engage stakeholders and participants, engender a two-way flow of information and disseminate findings to demonstrate impact. We argue that in the context of disaster recovery, dependencies between science communication and citizen science are critically important, particularly amongst communities physically and or emotionally impacted by disaster events. Through these projects, a connection between science and knowledge, government policy and initiatives, and public expectations and desire to contribute to recovery efforts after major natural disasters can be provided. It is generally acknowledged that the greater the increase in public participation in research, the greater potential there is to build trust in both the organisations involved and the science undertaken (Christopher et al., 2008). Both citizen science and science communication have integral roles in engendering trust in the science of disaster recovery by actively seeking to partner with communities in science. Science communication is central; needed to publicise events and enable the recruitment of participants at appropriate project scales and timelines. One of the many benefits of citizen science is the capacity for relatively rapid responses across vast spatial scales (Gibson et al., 2021), making science communication critical for communicating the opportunity to communities (Hecker, 2022).

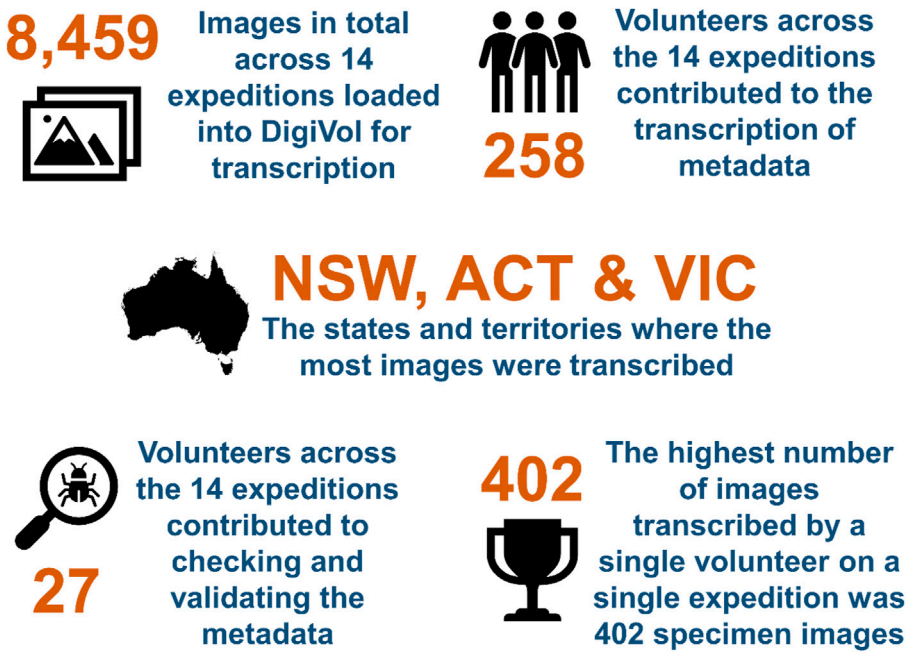


FIGURE 3
Insect digitisation project statistics on the DigiVol platform where volunteers transcribed specimen labels.

Communicating the impact of the science undertaken with participants is also critical and provides an understanding of the role of fire in landscapes and perceptions of recovery (Weill et al., 2020).

Promoting the whole program of work as well as the opportunities to participate were critical to the program's objectives to raise awareness of the work and attract participants. To ensure inclusive participation (although this is not something we were able to exclusively test), initiatives were developed that were accessible to a wide variety of people through both online and field-based activities, thereby catering for a range of interests, time constraints, mobilities and locations (Haski-Leventhal and Alony, 2021). A combination of methods (field, scientific collections, crowdsourcing) were employed to attract a variety of interests and target species of interest and areas of concern for monitoring (Steven et al., 2019). As testament to our approach, this program of work engaged hundreds of people directly in science and thousands of people indirectly *via* media, social media and newsletters. By generating more than 14,000 open access datapoints in the ALA across the three projects we ensured that this information was available for decision-making. To achieve these results, we needed to mobilise communication resources and use a mix of media to attract widespread participation and program uptake. We built a feedback loop into program findings so that participants could understand how they contributed to a broader program of knowledge. We did this through update emails and website blogs reporting on project findings and next steps. The accessibility of collections and data was increased so that data can be used in real-time application. It also served to provide communities a window into scientific collections rarely publicly seen and scientific approaches to fill gaps to inform management and decision-making (Steven et al., 2019).

Lessons learnt

Despite the success in attracting participants, a number of lessons became apparent from organising the three projects. Although largely out of our control, the bioblitzes were organised during the COVID-19 pandemic and had to be postponed from an ideal sampling period in spring to a summer/autumn period due to travel restrictions and limits on public gatherings. Unprecedented major flooding also occurred during our events, resulting in significantly lower turn-out than pre-registrations had indicated. For one event, flooding also forced the short-notice relocation of preferred sampling locations to a different locality and date. This resulted in a substantially smaller lead time to promote this particular event, which was reflected by the lower level of participation (Figure 2; Site 3). Crucially though, a number of interested locals who happened upon the events and were not aware the bioblitzes, were identified. Targeting local groups such as Landcare, bushwalkers and birdwatchers *via* community newsletters and meetings would appear to have been an overlooked channel of communication to promote events at the local level (Danielsen et al., 2018). Live streaming the event was also successful, suggesting this strategy should be adopted for future events to increase accessibility even further.

The Flora Connections Project received the most amount of publicity but attracted comparatively few participants. This was

likely because the survey method was complex and not well suited to a general audience, in line with observations made by Hochachka et al. (2012), that uncomplicated protocols attract larger numbers of volunteers. Although various active flora groups were directly approached, this did not translate to further levels of participation. Initial volunteer involvement rates prompted the creation of the iNaturalist "light" method; however, this new method was not widely promoted as it was developed after all the project publicity was concluded. This finding suggests that detailed data collection needs tailored systematic promotion. Since these initial results, the project employed a communications officer to engage directly with groups and help teach the method. The project is now engaging directly with university course co-ordinators teaching conservation and ecology and raising awareness of Flora Connections as a teaching resource. The protocols and tools are intended to be used as part of a newly created Threatened Flora Network across Queensland which will work directly with local amateur botany groups to collect data on threatened plants across Queensland, which should translate to increased future participation in the project.

Online insect digitisation specimen label transcription was very popular on the online platform with all expeditions completed within 4 days. The level of communication to promote this project was adequate, and indeed additional tasks ready for citizen scientists to undertake at the time of publicity would have been preferred in order to meet demand. Online projects are typically very popular as they can be undertaken at any given time and locality (Aristeidou and Herodotou, 2020). Online label transcription allowed volunteers a unique glimpse into biological collections that they would otherwise not witness. For example, some of the specimens digitised for this project (and transcribed) were over 100 years old, while other specimens were the first recorded images within the ALA and the Global Biodiversity Information Facility (GBIF).

Conclusion

The 2019/20 bushfires were a significant natural disaster which at the time of the fires, elicited a strong response from the community. This program responded to the interests of the Australian people and enabled widespread community involvement in the science of bushfire recovery. It was also designed to fill identified gaps in post-fire data and improve both community and science's understanding of environmental recovery. The program serves as an exemplar of how to successfully partner with communities, research teams and government to enable citizen scientists to make valuable and timely contributions to research. It also provides a framework that can be replicated in the event of other disaster events, thereby giving longevity to these kinds of initiatives. The success, measured by the volume of publicly accessible data generated, and the reach of the program across communities, is due to the strength of engagement with partners and citizen scientists, as well as the passion of the individuals involved in caring for their local areas. Ultimately, it was the coupling of science communication and citizen science that allowed for an enhanced public awareness of bushfire science and the contribution of communities to Australian biodiversity science.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

ER conceived of the idea in discussion with AK and ER drafted the manuscript with support, input and edits from AK. AK produced all figures. All authors reviewed the manuscript and agreed to the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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