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BUILDING AUSTRALIA THROUGH CITIZEN SCIENCE

*Gretta Pecl, Chris Gillies, Carla Sbrocchi and Philip Roetman**

Partnerships between scientists and the community are strengthening Australia's research capacity, solving real world problems and enhancing our awareness of science.

BACKGROUND

Citizen science brings scientists and the wider community together to work on important scientific projects. It has played a central and celebrated role in the advancement of global knowledge.

From amateur astronomers tracking the transit of Venus in 1874 to the Audubon Society's 114 year-old Christmas Bird Count, people with a passion for science have worked alongside scientists for the benefit of the community. Today, more than 130,000 Australians are active in over 90 citizen science projects[1], predominantly in environmental science fields. Many kinds of organisations are also involved, including universities, all levels of government, schools, industry groups, community groups and museums.

These diverse projects produce a large number of observational records that would be unachievable by a single scientist. Since 1998, 10,000 registered bird observers have produced 10 million records towards the Atlas of Australian Birds database.[2] More recently, the National Science Week program 'Explore the Seafloor' successfully analysed 330,526 photos of marine habitat within a one-week period through the efforts of 9628 citizen scientists.[3]

Australian citizen scientists have discovered new species (Figure 1), played a role in breakthroughs on debilitating diseases[4], identified and classified distant galaxies[5], and contributed to new ecological theories.[6]

Figure 1: Peacock spider, Maratus harrisi, *discovered by citizen scientist Stuart Harris.* Jurgen Otto, CC BY-NC-ND.

HOW DOES CITIZEN SCIENCE WORK?

Different projects call for different relationships between professional scientists and community members. Recognised forms of partnership include:[7,8]

- Contributory - citizens collect or process data for scientists
- Collaborative - citizens engage in work beyond data collection or processing, such as project design, analysis or communication
- Co-created - citizens and scientists work together in all aspects of the scientific process

Figure 2: The Atlas of Life in the Coastal Wilderness is a regionally-based, community-led project that has contributed over 11,000 species sightings to the Atlas of Living Australia in less than four years. It is a rich contribution to a large, long-term and critical data resource for the nation. Atlas of Life in the Coastal Wilderness, 2014.

Like any scientific endeavour, the appropriateness of citizen involvement and best form for that involvement to take have to be carefully evaluated.[9,10] Projects that require complex observation or data collection techniques will often call for skills that only years of professional training and experience provide. However, many projects are well suited to participation by members of the community, who can follow the principles of scientific inquiry[11] to make valuable contributions.

Projects with high citizen participation can harness the large number of contributors to extend the spatial or temporal scale of data collection (Figures 2 and 3). These projects typically involve a lower level of training for citizen scientists and simple methods of scientific data collection.

More complex projects require scientists to provide more training or support for citizen scientists. They typically involve fewer participants[6] or operate on a smaller scale (Figure 4) to ensure that high-quality evidence is obtained.

Figure 3: Over 500 people searched for koalas on one day in South Australia, recording 1500 sightings as part of The Great Koala Count. Researchers developed a model of koala distributions from the spatial data collected.[12] The project was run as a collaboration between the University of South Australia, ABC Local Radio, the South Australian Government, CSIRO and the local community. Philip Roetman, 2011.

ADVANTAGES OF CITIZEN SCIENCE

Citizen science has emerged over the past several decades as a powerful tool where one project can achieve multiple objectives. Tangible benefits of citizen science include:

For the research community: increased scale of data collection, new or greater access to resources, access to private lands and information.

For citizen scientists: education (either formal or informal) leading to new knowledge and skills, empowerment, friendships and more active lifestyles.

For society: new information for government decision-making, greater interest in science and understanding of scientific principles, greater

Figure 4: Earthwatch is an internationally successful model where citizen scientists join professional scientists to investigate environmental issues. In Australia, Earthwatch expeditions have contributed to over 300 peer-reviewed scientific papers. Earthwatch, 2013.

environmental stewardship and more engaging teaching methods for science and mathematics subjects, whilst helping scientists to understand people's concerns and aspirations.

As a distributed network of 'first responders', citizen scientists can monitor and notify authorities on issues such as pest and disease outbreaks, pollution breaches or the discovery of new species.

At the local scale, citizen science can support council and regional natural resource management biodiversity strategies, local forest initiatives or assist in the delivery of wildlife management plans.

Citizen science also incorporates local knowledge and historical accounts, and can embed these in monitoring and assessment programs (Figure 5).

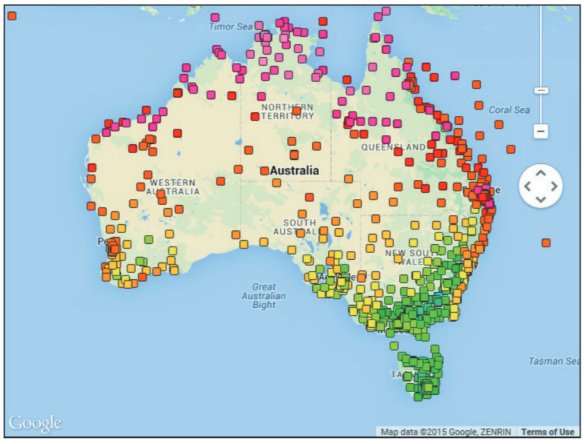

Figure 5: The Australian Bureau of Meteorology is working with the UK's Met Office to collect weather information and observations from citizen scientists. The project provides a high-density meteorological dataset (temperature shown on the above map) in a cost-effective and well-structured system. Bureau of Meteorology, 2015.

HARNESSING THE POWER OF COMMUNITIES

New technologies are enabling people in the community to collect data with more accuracy and precision than ever before. Smartphones can equip untrained citizens with the capacity for a high degree of accuracy in observations, allowing automated data collection and creating rigour through the potential of post-processing. For example, automatic recording of GPS location can reduce transcription errors, and photographic records can be verified by experts (Figure 6).

Moreover, advances in instrumentation such as devices that monitor and record temperature and acidity make it possible for non-experts to take reliable and precise measurements of an increasing number of parameters (Figure 7).

Figure 6: Participants in Range Extension Database and Mapping project (or 'Redmap') record and share observations of marine species that are unusual to a given area via a website or smartphone app. The data helps scientists to map changes in the distribution of marine species against changes in the marine environment. All photographic observations are verified by a member of Redmap's network of 80 scientists. Jonah Yick, 2015.

Figure 7: Citizen scientists in the DustWatch program monitor dust activity using instruments such as deposition traps and high volume air samplers. OEH/Simone Cottrell

OVERCOMING BARRIERS, BUILDING OPPORTUNITIES

A 2014 survey of 122 citizen science project leaders found that positive outcomes of projects included research outputs (papers, reports, presentations, theses or books), educational outcomes, contributions to policy and other impacts including behavioral change or increased awareness of issues (Figure 8).[1]

One barrier to maximising the potential of citizen science may be the perception within the scientific community. The survey found that 'perception of unreliable data' was ranked as the second major barrier to successfully conducting citizen science projects (after 'availability of funding'). Interestingly, the scientists actually involved in these projects ranked the reliability of data as much less of a barrier.

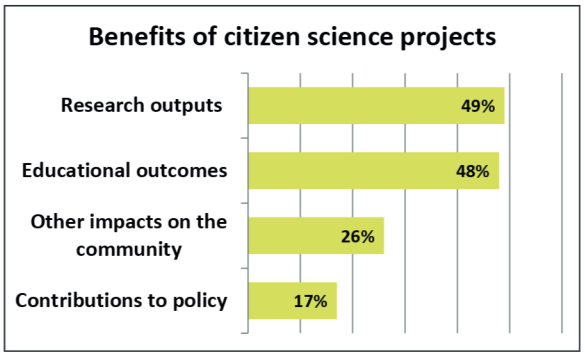

Figure 8: Positive outcomes of citizen science projects[1]

As the field of citizen science matures this perception appears to be shifting, possibly facilitated by the growing body of literature demonstrating that (where citizen science was an appropriate methodology) data collected by citizens are comparable to those of professional scientists.[13,14] Moreover, many processes and statistical methods have been developed to recognise and evaluate the types of data collected through citizen science.[10,15]

The success of citizen science projects is also reliant on the level of understanding and awareness of science in the community. Building scientific literacy can help to boost participation in science projects – and opening these projects more widely can improve scientific literacy in turn.

Shifting the perceptions within the research and Australian communities calls for new thinking and partnerships, focused on:

Training and the development of standards - so that individuals and organisations have greater capacity to deliver best practice citizen science, and provide scientists and participants with guidance on appropriate question selection, project design, methods of volunteer recruitment and engagement, techniques for data capture and analysis, safe practice in the field, communication with community leaders, and project evaluation.

Improving communication amongst citizen science projects, host organisations, practitioners and volunteers - to limit unnecessary duplication of projects and harness resources more efficiently, particularly within similar organisations (such as park agencies, environmental protection authorities, regional national resource management bodies and local councils).

Similarly, a national register of projects (such as http://www.scistarter.com) would provide a connecting service to prospective volunteers to discover nearby projects, match scientists to communities, identify data 'black spots' and provide support and training.

Developing forums for connecting scientists, educators, government, private industry and the community - to create new projects which address issues of local, state, national and/or global importance.

One promising development is the recent establishment of the Australian Citizen Science Association (http://www.citizenscience.org.au), a national community of practice for all types of citizen science within Australia. Bodies have already been established in the US (www.citizenscienceassociation.org) and in Europe (http://ecsa.biodiv.naturkundemuseum-berlin.de) and are playing a leading role in coordinating the growth of citizen science internationally.

CONCLUSION

Citizen science can be a powerful demonstration of what can be achieved when different stakeholders work together to address critical issues.[16] Providing opportunities for stakeholders to discover together where information gaps exist, and better understand the expertise, experiences and values of each group, would help to focus citizen science projects to where they are most needed and valued.

References are available at chiefscientist.gov.au

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* Gretta Pecl is from the Institute for Marine and Antarctic Studies at the University of Tasmania, Chris Gillies is from The Nature Conservancy, Carla Sbrocchi is from University of Technology Sydney and Philip Roetman is from University of South Australia.