Threatened Species Recovery Hub

National Environmental Science Programme

Citizen Science for Threatened Species Best Practice Framework

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Front cover: Volunteers undertaking a shorebird survey. Photo: Chris Purnell

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An enthusiastic base of volunteer birdwatchers, co-ordinated by groups like Birdlife, has contributed to threatened birds being the best monitored wildlife group in Australia. Photo: Rochelle Steven

Introduction

There is now ample evidence that citizen science has made and will continue to make valuable contributions to our understanding of the natural world (McKinley et al. 2017; Show 2015; Theobold et al. 2015). This Citizen Science for Threatened Species Best Practice Framework represents a key product of a three-year project examining the role and potential of citizen science to contribute to threatened species recovery in Australia, and globally.

Based on extensive review of the citizen science literature, as well as lessons learned during an on-ground citizen science project for the Critically Endangered western ringtail possum (*Pseudocheirus occidentalis*) (Steven et al. 2019; Steven et al. 2020; NESP TSRH case study factsheet on the western ringtail possum; NESP TSRH findings factsheet on the CAUL Urban Wildlife app; NESP TSRH factsheet on living with western ringtail possums) we present here a guide for conservation practitioners. Citizen science for threatened species in Australia is coordinated by a diverse suite of government and non-governmental organisations, many of which are supported by countless volunteers, the numbers of species listed as nationally threatened would be even greater (see the NESP TSRH factsheet overview of citizen science programs). We acknowledge the huge contribution organisations like BirdLife Australia, Discovery Circle and Atlas of Living Australia have already made in shaping the citizen science for threatened species landscape (Steven et al. 2019).

The framework draws on an extensive suite of information available to citizen science and conservation practitioners, collating many of these into a concise and easy-to-read product; as such, this is not an exhaustive document on designing and implementing a citizen science project. However, we hope that in highlighting the key elements presented here, practitioners will give due consideration to them when choosing citizen science as a mechanism to enhance threatened species recovery.

Threatened species conservation demands special consideration in terms of which methods and actions will best serve to improve these species' population and persistence trajectories. As these species may well be on the brink of extinction, any involvement by the general public needs to be done with the utmost concern for the species' welfare (Lindenmayer and Scheele, 2017; Tulloch et al. 2018). The last thing anyone advocating for conservation would want is conservation interventions that result in unwanted deleterious impacts. Hence this framework emphasises the need to choose citizen science approaches and methods carefully, especially when venturing into the habitats where these species persist.

Further information for practitioners interested in citizen science more broadly can be found via the Australian Citizen Science Association website, including the very useful 10 Principles of Citizen Science. These 10 Principles are designed to ensure the project is as inclusive as it possibly can be with respect to the participating citizens. For example, they highlight the importance of acknowledging participants and having due consideration for ethical and moral facets of working across social, cultural and ecological systems. Similarly, we encourage practitioners to peruse the Atlas of Living Australia and Biocollect websites.

The western ringtail possum is a threatened species that we can learn a lot about through citizens sharing their sightings with researchers via the CAUL Urban Wildlife App. Photo: R. Steven

Citizen Science for Threatened Species Best Practice Framework

The potential for citizen science and public participation to support threatened species conservation in Australia is enormous, and not yet fully realized. Several models and frameworks for successful citizen science programs have been developed and published overseas (Cooper et al. 2007; Bonney et al. 2009; Shirk and Bonney 2015; Pocock et al. 2017; Steven et al. 2019), and here we build on this foundation to develop a best practice framework to guide development and implementation in Australia. The aim is to understand how, when and why to deploy citizen science in a systematic and strategic manner to maximally enhance program success and threatened species recovery. We have identified five main stages of the process (Figure 1).

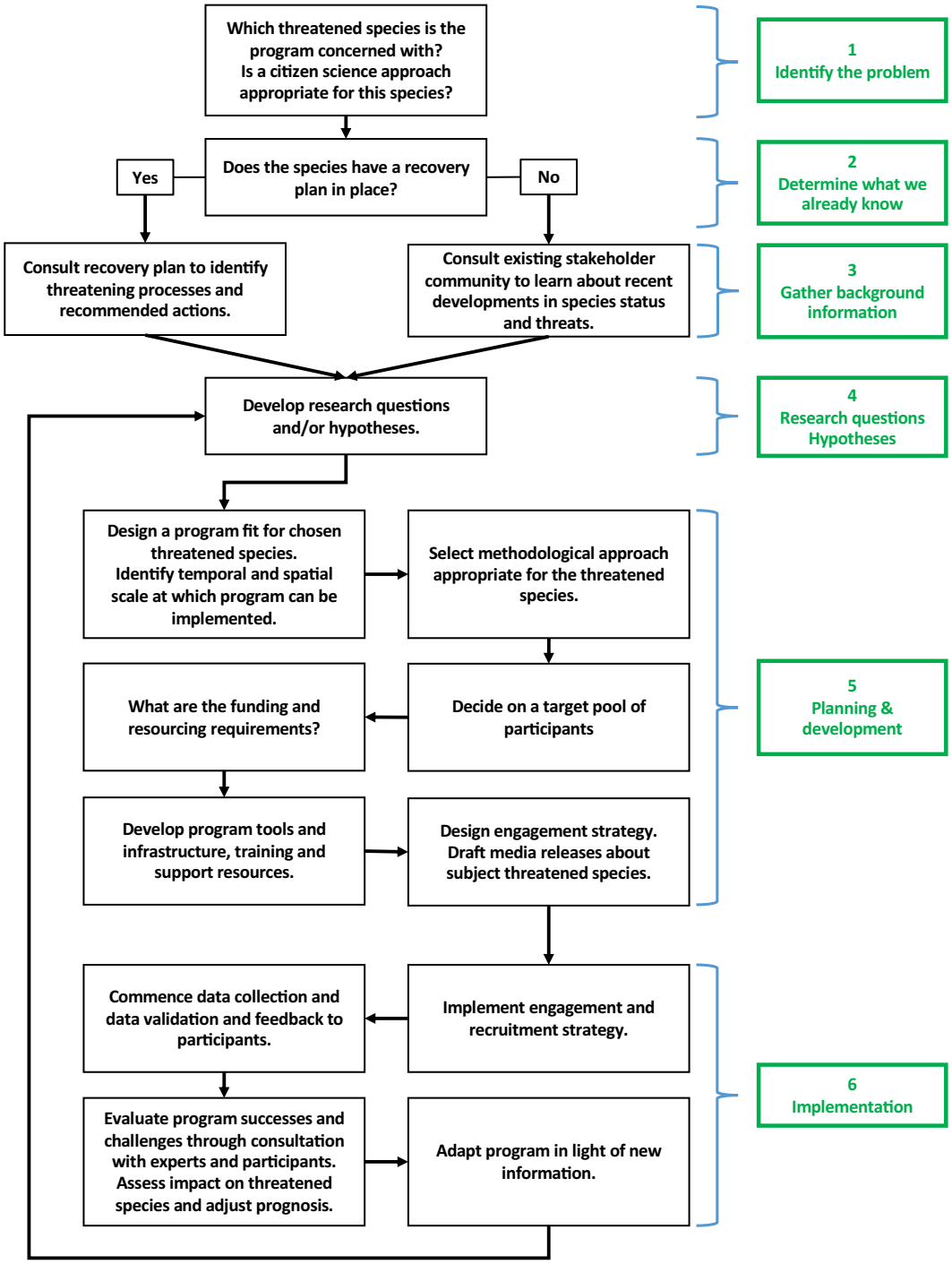

Figure 1. Schematic diagram of the Citizen Science for Threatened Species Best Practice Framework (Cooper et al. 2007; Bonney et al. 2009; Pocock et al. 2017; Steven et al. 2019).

1. Identify the subject species or group of species

Australia's national environmental legislation regarding biodiversity (Environment Protection and Biodiversity Conservation Act 1999 [EPBC Act]) currently identifies more than 1700 species as threatened with extinction. Stabilising and recovering the populations of threatened species is an enormous task that will require engagement and involvement by the broader public for effective threatened species recovery.

Organisations concerned with one or more threatened species conservation actions should first clearly articulate which species their efforts are focused on. Existing examples of programs that clearly define their target species includes, the Bilby Tracks program (Save the Bilby Fund), Brush-tailed rock-wallaby monitoring program (Office of Environment & Heritage (OEH) NSW) and National Malleefowl Monitoring Database (National Malleefowl Recovery Team). Where the program intends to cover a larger number of threatened species, e.g. migratory shorebirds, consideration of the full range of species covered is needed.

For some threatened species, the risks posed by engaging citizen scientists may outweigh the potential benefit (e.g. small populations of orchids, animals that have declined to dangerously low populations, species that are hazardous to people). However, most threatened species make ideal subjects for citizen science in some form. Citizen science can be a helpful mechanism to increase the efficiency of financial inputs for species less vulnerable to direct public interventions. Thus providing an opportunity to invest in professional monitoring and management for species most at risk or requiring specialist monitoring and management. The following section clarifies the necessary considerations in determining whether citizen science is an appropriate strategy for certain threatened species.

2. Determine what we already know

Recovery plans are the product of a collaborative effort by a multi-organisational team that distils the conservation status, known threats and recommended actions for an individual or suite of threatened species. Recovery teams are often led by government employees (state or federal) working closely with experts from the research and natural resource management sectors. Recovery plans are usually drafted as a publication by the relevant state government department. They are scrutinised by a recovery team to ensure that the issues and solutions identified are appropriate for the species in question. Once these are endorsed at the state level, and if the species is elevated to nationally threatened under the EPBC Act (1999), they may be adopted by the Commonwealth as the National Recovery Plan. It is critical to determine if a recovery plan exists for the focal species prior to planning a citizen science program for the species. Examples of recovery plans can be viewed on the Australian Government website, Species Profile and Threats Database.

Community members have contributed to the design of a citizen science program led by the Threatened Species Recovery Hub to support the conservation of the critically endangered western ringtail possum. The project will complement existing public participation events for western ringtail possums led by local catchment and conservation groups in south-west Australia. Photo: Boyd Wykes

3. Gather background information by (i) consulting the recovery plan to identify threatening processes and recommended actions, or (ii) consulting the relevant stakeholder community to learn about species status and threats

For threatened species conservation and recovery, it is imperative to ensure that efforts are designed and implemented in a way that gives them the best chance of success and impact. All too often, resources and energy are invested into programs or projects that ultimately do not achieve their goals and struggle to be sustainable over the time period required to execute the actions needed for effective outcomes. Such programs can end up wasting resources that could have been directed elsewhere to yield a better overall result for threatened species recovery.

When designing program for a threatened species that involves the general public, the first place to seek guidance for recovery and research actions that are outlined in adopted by recovery plans. Recovery plans generally follow a standard structure and tend to be written in a style that is digestible for readers beyond the research community. Consulting the recovery plan, especially if it is relatively recent in publication, ensures any actions undertaken by citizen scientists or conservation volunteers will align with the approved conservation actions already identified or implemented. It is also recommended to make contact with the authors of the recovery plan and/or the recovery team working on the implementation of recovery plan actions.

If there is no adopted recovery plan for the focal threatened species, in all likelihood, there will be some research and/or government personnel working on at least some aspects of the species conservation and/or management. **It is recommended to make contact with existing stakeholders early in the development and design of a public participation program.** Early communication with existing stakeholders is positive for several reasons:

1. If the species or region is new to you, it is important that previous contributions and efforts are acknowledged and recognised to minimise the alienation effect associated with venturing into 'their' territory;
2. The wisdom and background information the existing stakeholder base can provide will aid in developing any new program by learning from others' experiences;
3. There may be cross-over with existing public participation programs. In an effort to increase efficiency and maximise impact of any conservation actions, it is desirable to streamline methods and infrastructure and seek synergies from multiple actions wherever possible;
4. There may be benefits associated with resource sharing should a collaborative relationship with existing interest groups be initiated;
5. This is essentially incorporating a co-design component into a citizen science program. Co-designed citizen science cited as one of the best ways to achieve 'buy in' among the relevant stakeholders and thus the general public, with whom these stakeholders often work closely with at localised scales.

Birders undertaking Australasian Bittern Surveys. Photo: Andrew Silcocks

4. Research questions and/or hypotheses.

A recent review of citizen science and public participation in conservation of threatened species in Australia discovered that only 2% of programs clearly articulate the research question(s) for which answers are sought based on data collected by volunteers. Given the emphasis placed on developing a research question for any other professional scientific study (Steven et al. 2019), this is a concerning finding, especially for threatened species research. **Projects aiming to utilise the efforts of volunteer citizen scientists or public participants should clearly state their research questions, purpose, or hypotheses in their communications to potential and existing volunteers.** It is possible that many of the programs reviewed are driven by research questions at the time of development. However, to fulfil an additional criteria of many citizen science models, striving for inclusiveness towards volunteers in the whole scientific process is desirable rather than just the data collection aspect.

Citizen science collected information on Carnaby's Black Cockatoo has been utilised in recovery planning for the endangered species. Photo: Ralph Green Flickr CC BY NC ND 2.0

5. Planning and Development

The questions articulated in the preceding phase will, in all likelihood, guide development of the program design itself. Citizen scientists may assist in the development phase of the project (Hecker at el. 2018), particularly those that have already had involvement in recovery actions for the species. They can provide insights into whether the research questions posed are relevant to on-ground applications of conservation action as well as highlight issues of scalability in those actions. Additionally, citizen scientists may help in field-based activities at the outset of a program, perhaps installing nest boxes in experimentally selected sites or camera traps that they may subsequently check and process the footage. This has been the case for some projects that ask participants to install and monitor such camera traps on their own private land. Post data collection, citizen scientists may assist in data processing and analysis. Remotely processing sound and image files is an example of this kind of activity, which also outsources some of the computer power required for these types of programs. Finally, and potentially most importantly, citizens can play a critical role in communicating the findings of the program's research activities to other members of the community. This is a powerful mechanism by which the program satisfies the criterion of data interpretation and sharing. This also gives citizens the opportunity to contribute to raising the profile of the species conservation status and positive outcomes of the program with the wider community.

Resource availability and access to physical and technical infrastructure will usually dictate the spatial and temporal scale at which the program can be implemented. If the public participation component includes field-based data collection, the geographic distribution of the species may dictate the program's spatial scale. For species that are widely distributed, digitally interactive tools such as applications on smart devices will assist in efficient data capture. **Embracing new technology can improve the rigor in citizen collected data, including date and location data, as well as minimising handling errors associated with paper forms and post-collection data entry.** At this point a methodological approach to be used by the participants (i.e. citizen scientists) will also need to be selected.

- Will you ask citizens to conduct surveys using standardised methods? (e.g. point counts, transect surveys, timed surveys etc.)
- Will the program draw on opportunistic or incidental records only?
- Will the program accept records for proxy or surrogate measures of species presence?

Which approach you choose will depend on the research questions being asked, the scale at which the program will be implemented and the likelihood of encountering the target species. This final point is worth pondering for a moment. **When engaging citizens in research, especially of a biological nature, keeping participants engaged is challenging (Eveleigh et al. 2014; Nov et al. 2014).** Participants want to feel like they are actually achieving and contributing something! For threatened species that occur in relatively high densities across a small geographic area, it may be appropriate to employ standardised survey methods, given the higher chance of encountering the species. This can be coupled with directing participants to the edges of known population ranges to gauge densities in under-surveyed areas where more information is needed about the species persistence and abundance at larger spatial scales. This approach is also more rigorous in the sense that we learn about absences as well as presences. Conversely, if the species occurs at generally low densities, incidental records may be the best chance of acquiring any data at all for where the species persists. Likewise, incidental or opportunistic methods can be useful for engaging members of certain communities that may be unfamiliar with the species and lack the skills to conduct standardised surveys at that point in time. This may change as participants learn from the mere act of observing and becoming more aware of the species in their surrounding environment. Finally, providing the ability to submit records for proxy or surrogate measures of presence (e.g. dreys for western ringtail possums, evidence of frequented habitat trees for certain parrot species, scats) can provide the motivation for participants to stay involved in the absence of direct observations of the species.

If the use of digital media platforms is required, or any other data management infrastructure for that matter, this will need to be mapped out clearly in order to calculate any relevant costings for the program. **Start-up and maintenance costs need to be considered (Thornhill et al. 2016) and identifying sources of funding will be required to make the program happen.** However, identifying potential funding sources may also be influenced by who the target pool of participants will be. For example, if high school students will be engaged, and educational benefits of participation can be demonstrated (which should be the case as it is a criterion of citizen science in many frameworks) then funding may be sought from government educational bodies. Similarly, programs that can deliver information about a threatened species ecology and conservation status may be attractive to natural resource management agencies at the local and state government level. Finally, crowdfunding is a relatively novel mechanism that biologists and conservation practitioners are exploring as a means to fund a diverse array of on-ground and ex-situ conservation projects. This may be especially useful in appealing to members of the public that may not be able to participate in the program in a hands-on manner but would like to make a contribution nonetheless. If crowdfunding is a chosen strategy, feedback mechanisms to communicate what they have invested in will need to be articulated at the time of promotion.

Training and information resources provided to participants can enhance the rigor of data collected by citizen scientists. These resources can make use of modern technology just as you might for the data collection mechanism itself. Video clips providing demonstrations in how to collect data as well as providing background information into the project can be relatively inexpensive to produce and distribute. Examples of online training videos for various citizen science programs can be viewed on BirdLife Australia's YouTube channel and Australian Museum's YouTube channel for FrogID. Likewise, websites and social media pages make file sharing (written media pertaining to the project and methods of participation) easy for anyone with access to the internet. Biocollect provides an extensive list and repository of information about various citizen science projects, including many relevant for threatened species. Reviewing some of these can give guidance on what information can be easily shared with potential participants.

The importance of training is heightened when concerned with threatened species. Participants may find it very exciting to have the chance to not only encounter a threatened species, but also contribute to their improved conservation and management. Most participants will respect the need to put the species welfare first, but some may unwittingly put the species at risk through: trampling habitat, causing disturbance to the species during times of breeding or rest or even deliberately removing the species from its habitat, for any number of reasons (well-intentioned and not). It is at the training stage that the importance of mitigating any potential negative impacts must be made clear.

Once a prototype of the program is developed, it needs to be trialled and tested among a sample of potential users and stakeholders. During the early phases of this process, you will have collected the background information to guide the actual development of the program. You will know what aspects need to be very clear to ensure it is user friendly for the majority of participants. It is unrealistic to think that every single person that expresses an interest will be able to contribute valid data, but you should aim to make it accessible for the vast majority. A testing period prior to launch is critical to ensuring you have achieved this. It is also important to allow ample time to modify and update the program design in light of any feedback received.

The engagement phase is when you start to promote the project (beyond the initial stakeholder communications) and reach out to the target participant pool. As such, the success of your program rests heavily on how well you design your engagement strategy. Questions to ask yourself:

- When thinking about your target participant pool, what types of communication channels do they use?
- Have you got any experience with this mode of communication? If not, do you have anyone in your network that does?
- How can you catalyse a snowballing technique that uses engaged citizens to on-sell the program to their network?

When you have answered these questions, you can begin planning a timeline of events (with actions and deadlines for all of your supporters and co-coordinators). Setting an agenda prior to the launch of the program ensures everyone understands what is expected of them and gives structure to your day to day activities. These timelines or agendas are also useful for when media get in touch with you, as they may want to share your program as part of their communications. If the species you are working on is often featured in the media, it is strongly advised you take advantage of any media training you may have access to. Similarly, now is the time to prepare media releases to coincide with the launch of your program. This will not only aid in promotion of your citizen science program, but also heighten the species' public profile more generally. Things to consider sharing in any media releases include: population trajectories, threatening processes, current conservation actions and success stories, as well as the aims and objectives of your citizen science program.

As over harvesting by orchid enthusiasts is a key threat to the Endangered swamp orchid (Phaius australis), the remaining wild populations are shrouded in secrecy. Opportunities to engage the public in recovery actions of this species would therefore be best channeled into managing captive or semicaptive populations, with a view to re-introduce the species back into formerly occupied areas.. Photo: Rochelle.Steven

6. Implementation

With all of the planning and development done, it is time to implement a citizen science program for your target threatened species. While a launch event with fanfare and hype can be great for gaining attention over a short period of time, a sustained series of launch events may be more appropriate for species that have ranges that cover multiple planning units. For example, a species that has several sub-populations spread across several local government areas, it would be beneficial to plan events that are tailored for each of those human communities (See Box "Designing and implementing a citizen science project for the western ringtail possum" on page 11. What works in one area may not be successful in another. Depending on your target participant pool, you may choose to utilise stakeholder networks already working on the threatened species recovery. They can act as conduit between you and the participant pool you are trying to engage. Conversely, these groups may be hesitant to try new communication and engagement strategies. In these instances, it can be beneficial to seek coverage and promotion from novel sources independently. In this way, you can offer the existing stakeholder network the opportunity to observe new strategies of engagement without investing their own time and resources into an area they are not confident navigating.

Participant recruitment is the first chance program coordinators have to build rapport with participants and garner commitment to the program. For this reason, it is imperative that the program is communicated clearly and the recruitment process is well organised and relatively seamless. Participants will quickly lose patience if they are inconvenienced by: errors in communications about launch events and training sessions, misunderstandings about what exactly is expected of them and technical glitches in any digital platform the program is utilising for data capture and management. If the program is drawing on participants collecting data about a threatened species, this should now commence. It is important to allow for a period of troubleshooting with participants, despite having had a trial period, there will still be lessons learned during this time.

Shortly after initial launch (approximately 2-3 months), a first round of results and feedback should be communicated to participants, stakeholders and the general public ACSA 2020 https://citizenscience.org.au/10-principles-of-citizen-science). It also provides these key players an opportunity to provide their thoughts and ideas regarding these initial data. An early appraisal sets a benchmark for transparency going forward with the project and provides the opportunity to highlight aspects that may require adaptation at the first formal evaluation. Admittedly, data collected by this stage will be rudimentary in nature. There should be an adequate amount of information to draft a fact sheet at least, and potentially issue a media release while it is still fresh in the minds of local media providers.

After the first six to twelve months, there may be ample data and participant feedback accrued to perform a first evaluation of the project. In fact, this should be done every six to twelve months if the program is ongoing – in a continuous effort to adapt and improve the methods and strategies selected for the threatened species you have focused on. There are established evaluation frameworks for citizen science, but we offer the following as questions worth pondering:

- How many participants have you recruited and how many are still participating?
- Have you asked why people are no longer participating?
- Have you collected enough data to begin to answer at least some of your research questions?
- What does the data tell you about the threatened species' population distribution, behaviours, ecology and trajectory?
- Have the data revealed anything you did not expect?
- What have been the most frequently communicated challenges among participants?
- Have you achieved any other measurable successes?
- How can you adapt the project to either a) answer your initial questions, b) answer newly arisen questions or c) provide information to stakeholders and decision makers pertaining to the threatened species persistence across its range?

This part of the framework provides multiple benefits to the program, the target threatened species and the participants themselves. The program can be moulded to better fit the needs of the species and the abilities of the participants. Additionally, the participants see how their data build a more complete picture of the species' status and made aware of the instrumental role they are playing in shaping the species' conservation and management in the future.

Designing and implementing a citizen science project for the western ringtail possum

In 2017, the Threatened Species Recovery Hub commenced planning a citizen science and public participation project for the Critically Endangered western ringtail possum (Pseudocheirus occidentalis). The western ringtail possum (Ngwayir) (hereafter WRP) is an Australian Government top 20 priority mammal species and is listed under both the EPBC Act and Biodiversity Conservation Act (WA). The species occurs in a mix of habitats, including suburban areas, where a lack of awareness among the public about species' status, and knowledge gaps about the species' urban ecology are considered impediments to successful conservation. A citizen science program was considered an effective way to address some of these issues. We worked with stakeholders to design an on-ground project that engages the public in threatened species recovery. The project could also inform this guidance framework and conservation engagement more generally.

By consulting with numerous stakeholders across the federal, state and local government sector, as well as local natural resource management groups, researchers, wildlife rehabilitators, private enterprise and the general public, we designed, implemented and supported several citizen science initiatives within our own project scope as well as collaborators also working on western ringtail possums. These relationships and collaborations were the result of an extensive engagement strategy led by the Threatened Species Recovery Hub in the South West. A series of initial meetings, followed by community focus groups and workshops provided an abundance of insights and information into the status quo of citizen science for the species as well as public engagement in conservation more broadly. The time taken to build these relationships and rapport (6–12 months) illustrates the significance of these activities and the importance of not rushing people to garner support and buy-in when working within their respective jurisdictions.

Western ringtail possums use fences to traverse the urban matrix. They are an important piece of human infrastructure that enable this threatened species to co-exist with us. Photo: L. Knight

The citizen science activities related to this project include:

- Initial scoping and consultation with key stakeholders to determine where information gaps persist for western ringtail possum urban ecology and conservation.
- An online questionnaire in Bunbury, which is the urban centre in the western ringtail possum's range that is their second largest, but where they occur at higher density than in the largest urban centre.
- Surveys of Albany and Bunbury private properties to test species identification accuracy between householders and professional ecologists.
- Design and launch of a citizen science monitoring tool for Australia's possums and gliders, flagshipped by the western ringtail possum (CAUL Urban Wildlife App – possum and glider module – available from Google or Apple).
- Production of flyers and media that outline the objectives of the tool and how users can contribute.
- Community training workshops in Western Australia and Tasmania illustrating to members of the public what the objectives of the tool are and how they can contribute. The Western Australian workshops also included providing attendees with the opportunity to take conservation action on their own properties by planting habitat plants for western ringtail possums.
- Feedback seminars in collaboration with key stakeholders and partners, sharing initial findings of the citizen science research back to the public.
- Publishing research resulting from the citizen science activities in open access format so citizens can see how their efforts have informed science and management recommendations for western ringtail possums and citizen science project design.

Western ringtail possums consume many different plant species in urban gardens, foraging on a bottlebrush in this image, yet this is poorly understood across sub-populations. The CAUL Urban Wildlife App hopes to uncover some of the urban dietary preferences of the species. Photo: Rochelle Steven

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Further information:
http://www.nespthreatenedspecies.edu.au/

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