ARID RECOVERY

The Research Impact of Arid Recovery

BHP

Government of South Australia
Department for Environment and Water

THE UNIVERSITY of ADELAIDE

BUSH HERITAGE AUSTRALIA

Arid Recovery is a conservation initiative supported by BHP, the Department for Environment and Water, the University of Adelaide, Bush Heritage Australia and the local community

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Executive summary

Arid Recovery is an independent not-for-profit organisation in South Australia that is undertaking high-quality scientific research to inform conservation in arid ecosystems. Our primary research goal is to improve conservation practice for the recovery of threatened species and arid ecosystems. There have been 107 publications associated with Arid Recovery as at 2020, covering several areas addressing our research goal and related themes in ecology and conservation.

Collaboration is an important feature of our research program. We have collaborated with 76 organisations, including 23 Australian universities, nine international universities from four countries, and five international non-university research organisations from three countries.

Arid Recovery makes a significant contribution to advancing women in STEM (science, technology, engineering, and mathematics). Of the papers published, women were the lead authors of 65% and, on average, 59% of authors were women. We also support female students: of the 40 undergraduate and postgraduate university students whose research we have supported, 31 are women.

The research generated by Arid Recovery is having a high impact in the scientific community. This is demonstrated by paper citation rates that are high, high scores in metrics for the collective impact of these citations and the publishing of papers in high impact journals.

Ultimately, Arid Recovery research aims to inform on-ground management and policies in the conservation of threatened species and arid ecosystems. A key achievement is that our signature 'floppy top' cat-proof fence design is now used in 23 reserves across Australia, providing 58,000 ha of 'safe havens' for threatened mammals. We also pioneered the use of Eradicat® feral cat baits in South Australia, and these are now used across more than 5,000 km2 of national park and adjoining properties in the state government's Flinders Ranges Bounceback program.

Another goal at Arid Recovery is to raise awareness of arid zone conservation among the broader public. One way we measure our impact is using Altmetrics (alternative metrics), which uses non-traditional indices to measure the impact of scientific research on the general public, for example from social media, blogs, and news media. We are confident that our research and awareness raising is leading to improved understanding among the general public of the importance of our arid ecosystems.

Acknowledgement of Country

Arid Recovery is on the lands of the Kokatha people. We work together with Kokatha and other First Nations peoples to combine traditional knowledge and science to promote healthy Country.

Introduction

Arid Recovery is an independent not-for-profit organisation running a 123 km^2 conservation reserve in South Australia's arid north. Our vision is to lead sustainable restoration of arid ecosystems by using science to inform conservation.

High-quality research, and the publication of that research in reputable publications, are central to the purpose of Arid Recovery. Since 1999, we have conducted and published research on many themes around arid zone conservation and with a wide variety of local, national, and international collaborators.

This paper summarises the research and publications by Arid Recovery and analyses the researchers, authorship, and collaboration involved. We also provide metrics that assess the impact of this research, both in the scientific community and in the broader community.

Overall statistics

Arid Recovery maintains a database of scientific publications, which as at January 2021 includes 107 papers published since 1999. The number of papers published each year is trending upwards, including a substantial increase in output over the past three years (Figure 1).

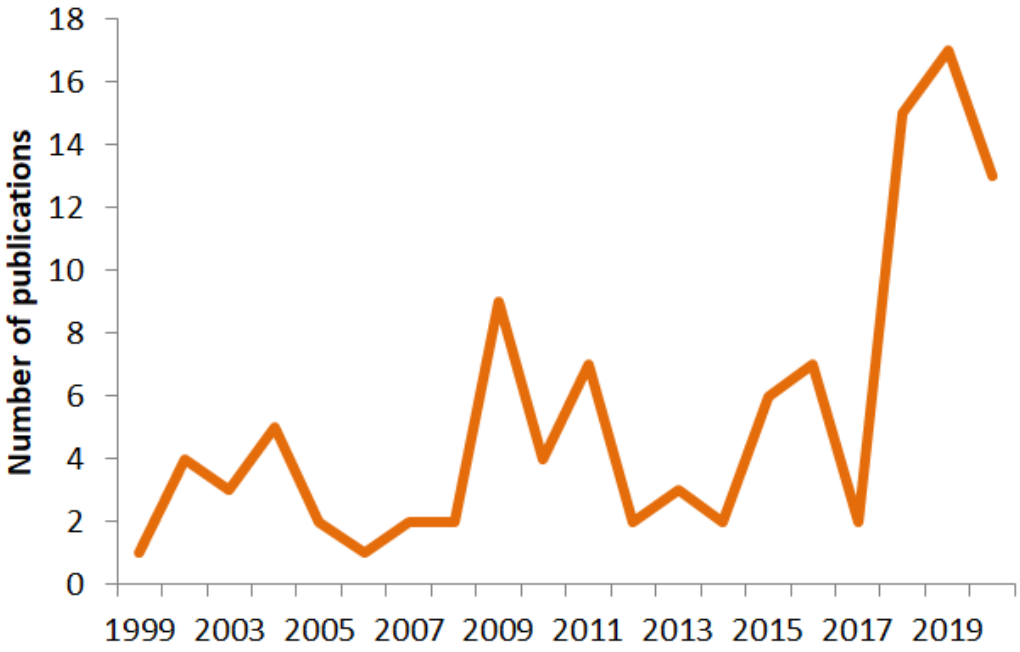


Figure 1. Cumulative number of Arid Recovery papers published per year.

Our research themes

Our primary research goal is to improve conservation practice for the recovery of threatened species and arid ecosystems. We hope this research will be useful to wildlife conservation beyond outback South Australia (Arid Recovery, 2019).

Our published research can be placed into the following eight broad themes or categories (each with a one-word code in parentheses):

i) beyond the fence solutions, including predator training ('Beyond')

ii) climate change impacts and adaptations ('Climate')

iii) fence design and management ('Fence')

iv) general biology and/or ecology ('General')

v) monitoring and methodology ('Monitoring')

vi) introduced predator control, especially feral cats ('Predators')

vii) threatened species reintroductions and management of fenced populations ('Reintroductions')

viii) ecosystem restoration, including *in situ* species and vegetation ('Restore').

The distribution of the 107 papers in these themes is shown in Figure 2. The themes with the most papers are 'Reintroductions' (n = 27) and 'General' (n = 26). One paper relates to climate change impacts and adaptation ('Climate'). Some papers are relevant to more than one theme.

The relative frequency of key words in the titles of papers published by and with Arid Recovery is illustrated in Figure 3. Unsurprisingly, words such as 'predator', 'reintroduction', and 'arid' are prominent.

The number of citations for each paper across the eight themes is shown in Figure 4. The median number of citations per paper (M) within a theme ranges from M = 5 for 'Monitoring' to M = 19 for 'Predators'; this shows that, on average, papers about introduced predator control have attracted more attention than papers about monitoring and methodology. Papers about ecosystem restoration ('Restore'; M = 14) and threatened species reintroductions ('Reintroductions'; M = 12) have also attracted relatively high attention. The individual papers with the most citations were in the themes 'Reintroductions' (127 citations), 'Predators' (113 citations and 81 citations), and 'General' (82 citations) (Figure 4).

Percentage of Publications by Theme of Study

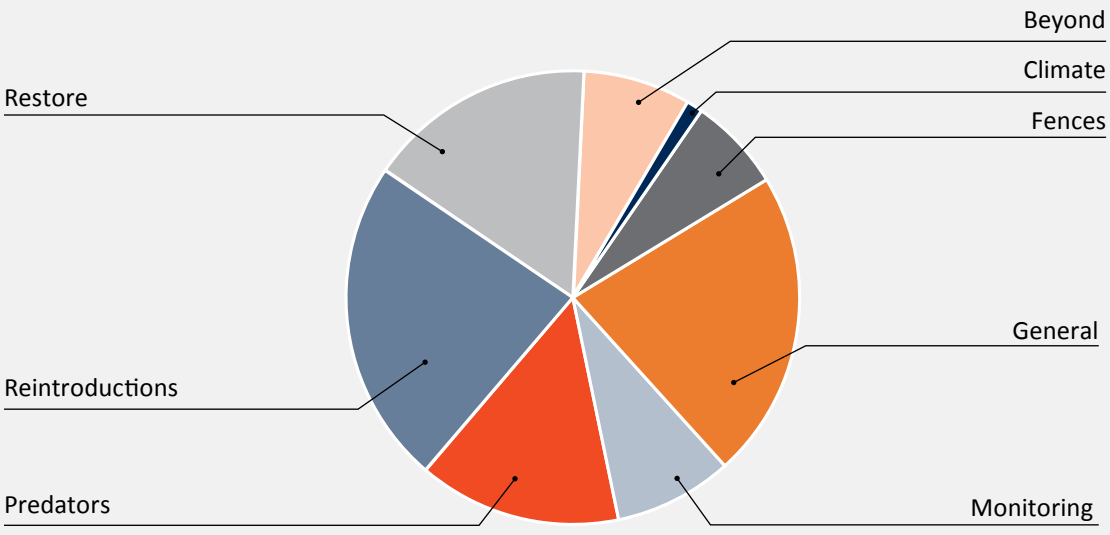


Figure 2. Distribution of Arid Recovery papers in themes (see text for explanation of categories).

Figure 3. Relative frequency of key words in the titles of Arid Recovery papers (where word size is proportional to the relative frequency with which words appear in paper titles).

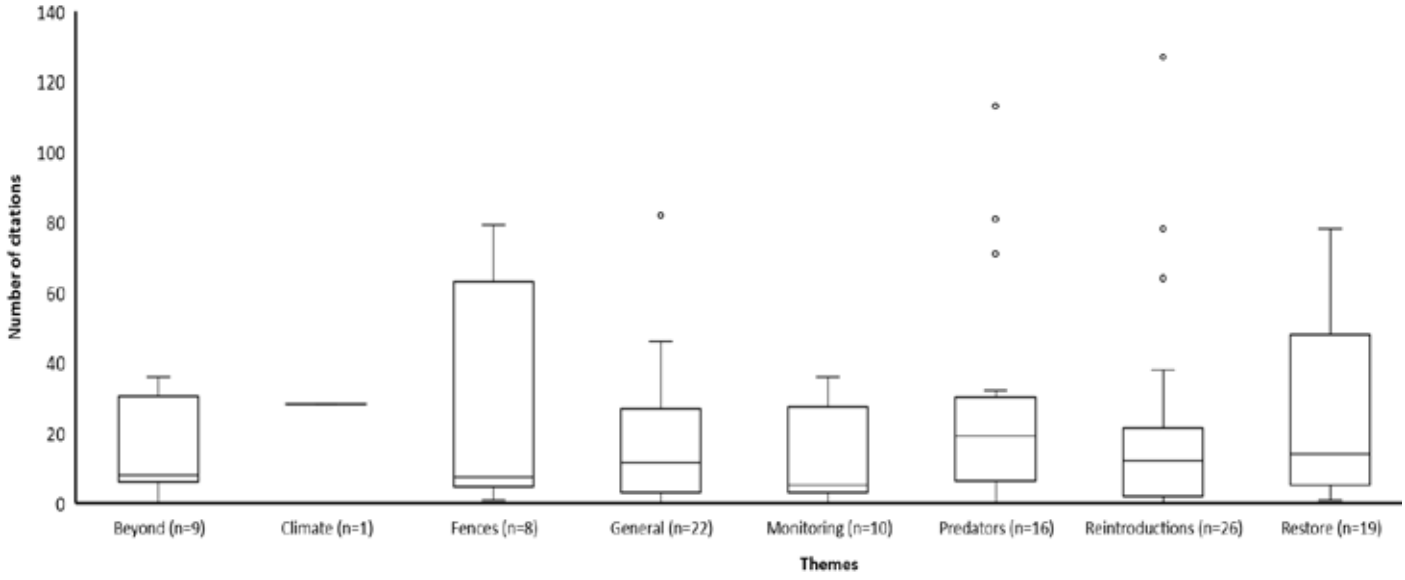


Figure 4. Number of citations per paper per theme. Boxes represent quartiles, whiskers are 1.5x the inter-quartile range (IQR), outliers (open circles) are outside 1.5x the IQR, and the horizontal line in the box is the median. n = number of papers within the theme. See text for explanation of theme categories.

Our researchers and collaborators

Organisations and authors

Although we only have a small number of full-time staff, Arid Recovery works with scientists across Australia and the world. Since 1999, Arid Recovery has collaborated on scientific publications with 76 organisations (see Appendix 1 for the full list). These include:

- 23 universities from the eight major states and territories of Australia
- nine international universities from four countries (France, Japan, UK, and USA)
- 17 local, state, and federal governments from the eight major states and territories
- three other Australian non-government conservation organisations
- one Indigenous organisation
- five international non-university research organisations from three countries (Germany, Japan, and New Zealand).

The pooled collaboration scores (number of authors multiplied by the number of publications with an organisation listed as an affiliation) for different organisations for locations in Australia and internationally are illustrated in Figure 5 and Figure 6; these show the relative contribution of different organisations from those locations to Arid Recovery publications.

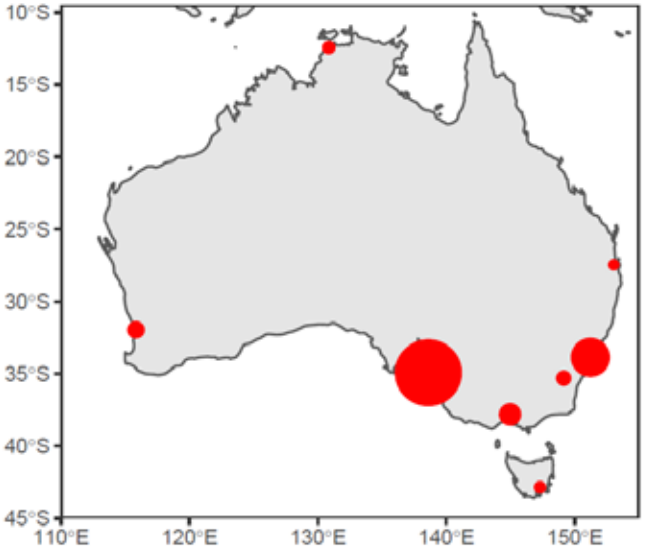


Figure 5. Locations within Australia showing the pooled collaboration scores (see text for explanation) for different organisations from those locations that have collaborated on scientific publications with Arid Recovery; the larger the circle, the higher the collaboration score for organisations from that location.

Figure 6. Locations across the world showing the pooled collaboration scores (see text for explanation) for different organisations from those locations that have collaborated on scientific publications with Arid Recovery; the larger the circle, the higher the collaboration score for organisations from that location.

Arid Recovery publications have lead-authors from 30 different organisations. Approximately half of papers (51%) have lead-authors from 16 universities across the eight states and territories of Australia, particularly the Universities of Adelaide and New South Wales. Arid Recovery staff have been lead author on 35 papers (33%), five government groups have been lead author on 7% of papers, and five other groups have been lead author on the remaining 9% of papers (Appendix 1; Figure 7).

The relative contributions of different authors to Arid Recovery papers are illustrated in Figure 8, in which name size is proportional to the frequency of publications with Arid Recovery.

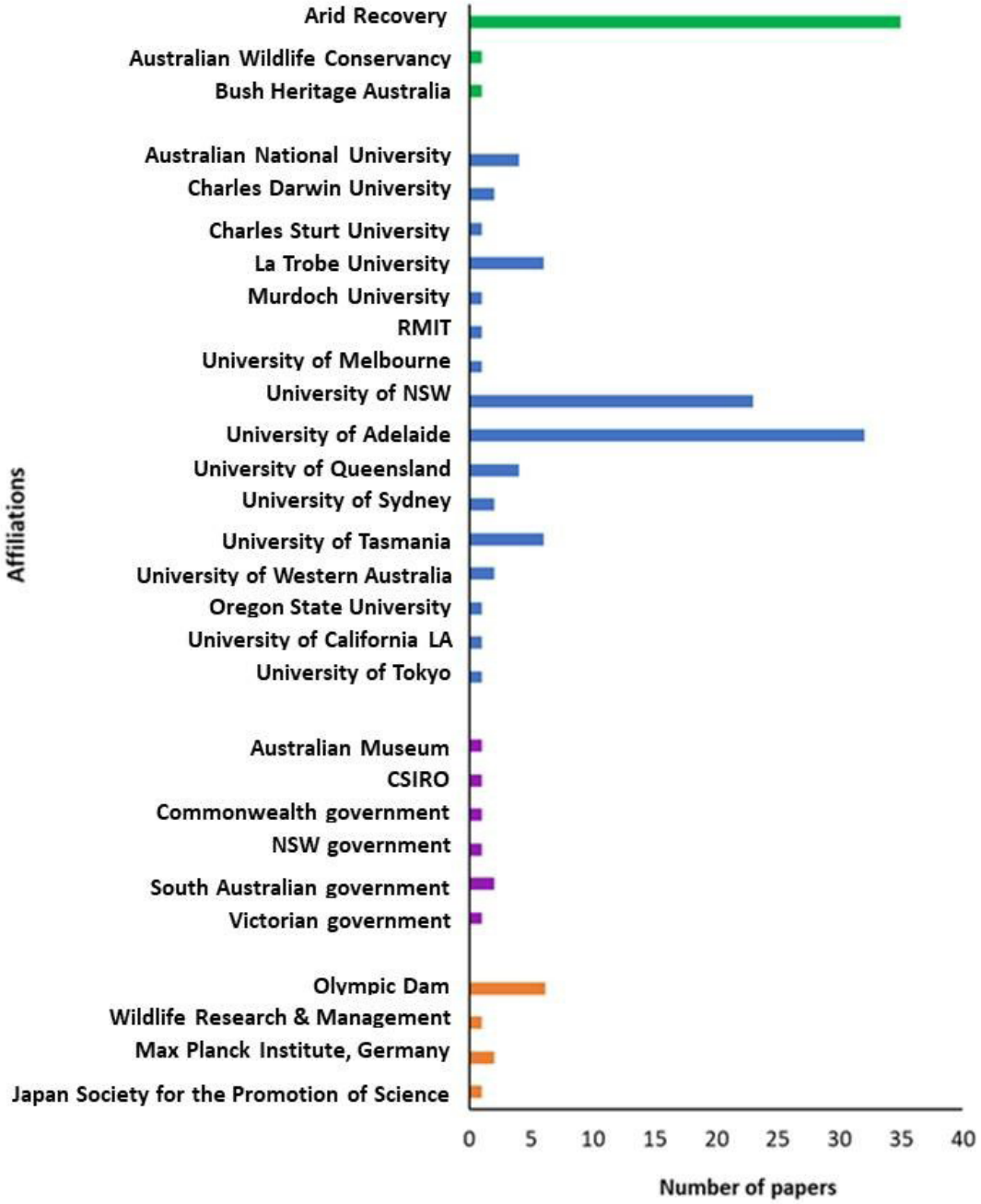


Figure 7. The affiliations (organisations) of researchers who have lead-authored Arid Recovery papers, and the number of papers on which they have been lead author. Green = non-government conservation organisations; blue = universities; purple = government organisations; orange = other groups. See Appendix 1 for abbreviations.

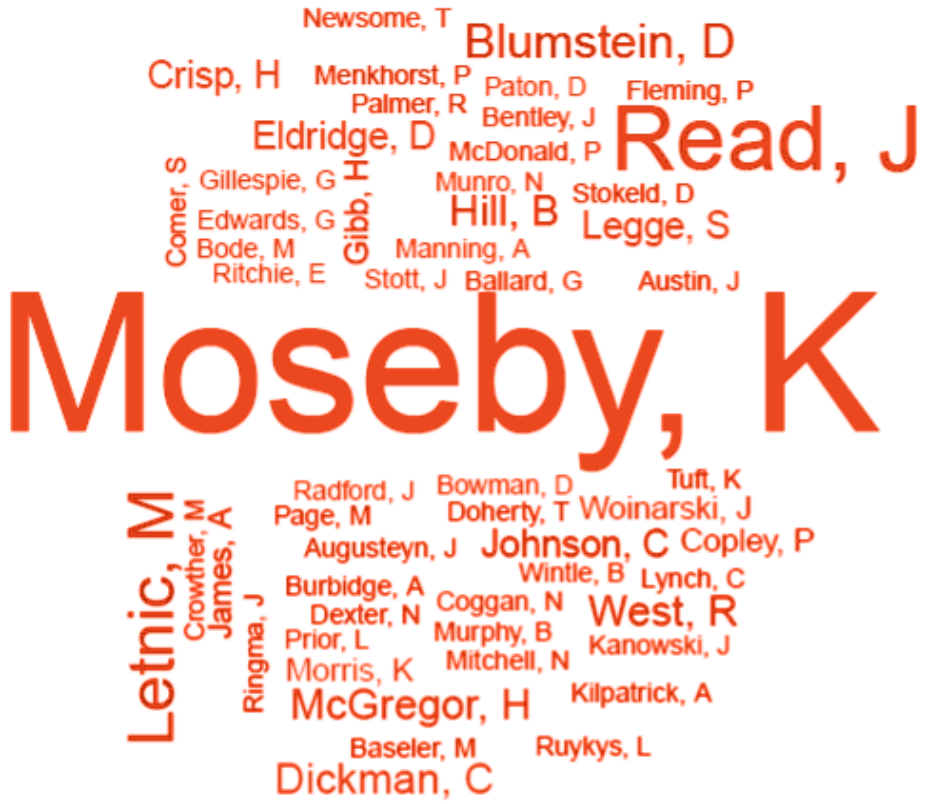


Figure 8. Relative contributions of different authors to Arid Recovery papers (where name size is proportional to the frequency of publications with Arid Recovery).

Type of research

Papers published by, and with, Arid Recovery can also be categorised by the type of research conducted, as follows:

- 'Collaboration', involving a mutual collaboration between Arid Recovery staff and external researcher(s)
- 'Internal (home)', involving research driven by internal researchers and conducted at Arid Recovery
- 'Independent using AR', involving research conducted at Arid Recovery but driven and conducted by external researchers.

To date, 58% of published research has been 'Internal (home)', 27% has been 'Collaboration', and only 15% has been 'Independent using AR' (Figure 9). This highlights how influential Arid Recovery staff are in the high-quality publications that are being produced.

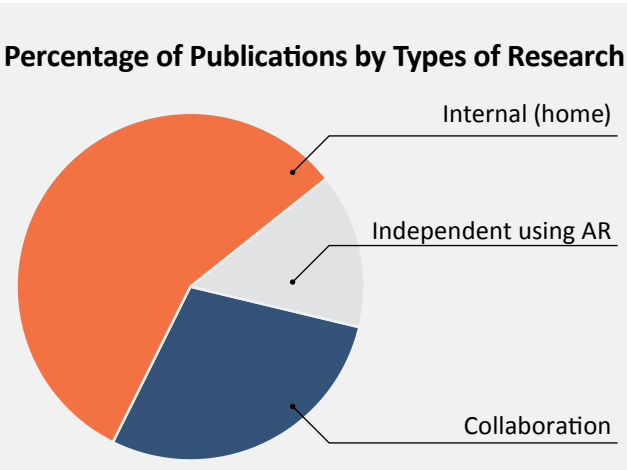


Figure 9. *Distribution of Arid Recovery papers in categories of the type of research (see text for explanation of categories).*

The number of citations across the three categories of research type are shown in Figure 10. The median number of citations per paper (M) and the mean number of citations ($\bar{x}$) within a group are relatively consistent across the three types of research (M = 10.5, 12, and 15, and $\bar{x}$ = 18, 23.5, and 18.7, for 'Collaboration', 'Internal (home)', and 'Independent using AR' respectively; Figure 10). This suggests the quality of research is relatively consistent across the types of research produced by, and with, Arid Recovery. The individual papers with the most citations are largely a result of 'Internal (home)' research (113 citations and 127 citations), further highlighting the significance of Arid Recovery staff in the high-quality research being conducted (Figure 10).

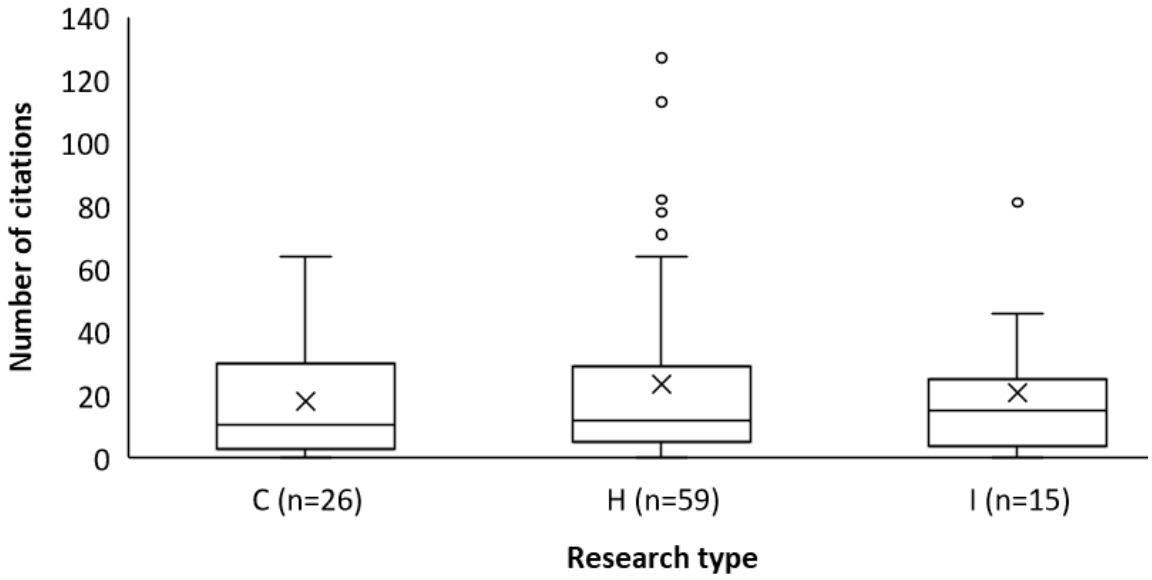


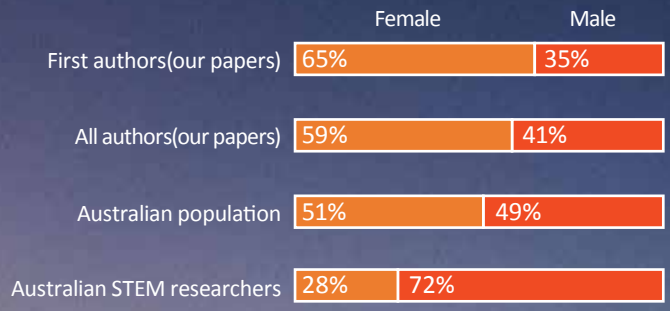
Figure 10. Number of citations per paper per research type category. Boxes represent quartiles, whiskers are 1.5x the inter-quartile range (IQR), outliers (open circles) are outside 1.5x the IQR, the horizontal line in the box is the median, and the x indicates the mean. n = number of papers within the research type categories. Research type categories: C = 'Collaboration', H = 'Internal (home)' and I = 'Independent using AR' (see text for explanation of categories).

Arid Recovery and women in STEM

It is well-known that women are underrepresented in the combined fields of science, technology, engineering, and mathematics (commonly referred to as STEM). For example, women account for only 27% of the entire STEM workforce in Australia and only 28% of STEM teaching and research staff, *STEM Equity Monitor Data Highlights 2021*, Australian Government Department of Industry, Science, Energy and Resources.. When the medical sciences are included, women comprise just under half of STEM undergraduate and postgraduate enrolments at Australian universities (SAGE, 2016).

Arid Recovery is notable for promoting women in STEM. Of the papers published, women were the lead authors of 65% (69 papers) and there was a total of 104 female authors (39% of unique authors). On average, 59% of the authors of papers were women.

Arid Recovery has supported the research of nearly 40 undergraduate and postgraduate university students, including 31 female students. To date, there have been 19 completed Honours theses (15 female), one Masters thesis (female) and nine PhD theses (all female). There are currently six PhD students working at or with Arid Recovery, five of whom are female.



Scientific impact of Arid Recovery research

Citations

Research impact is typically quantified by the number of citations a paper receives. Online databases that provide access to scientific literature (e.g. journal articles, theses, books, and book chapters) are useful resources for collating citation data. There are several such databases, with Web of Science and Google Scholar two of the better known. These two databases collate their citation data differently. For example, Web of Science only includes citations that appear in primary, peer-reviewed literature, whereas Google Scholar also includes data from non-scientific sources, such as mentions in non-peer-reviewed literature. Here, we present Web of Science data first with Google Scholar data in brackets.

Papers produced by, and with, Arid Recovery have been cited a total of 2,166 (3,183) times, with a strong trend of increasing citations per year (Figure 11), which reflects the increasing impact of Arid Recovery research within the scientific community.

Metrics are available for assessing the collective impact of the citations of these publications (i.e. how productive and influential Arid Recovery has been through their publications), including the *h*-index and *i10*-index. The overall *h*-index for Arid Recovery papers is 27 (33), meaning that 27 (33) of the papers have been cited at least 27 (33) times, while the *i10*-index is 56 (68), meaning that 56 (68) of the papers have been cited at least 10 times. When the *h*-index was first introduced to scientific research, the creator (Jorge Hirsch) suggested that, after 20 years of research, an *h*-index of 20 should be considered good, while one closer to 40 is outstanding. Given that Arid Recovery papers have an *h*-index of 27 (33), coupled with an *i10*-index of over 50, it is clear that Arid Recovery has been both productive and influential in the field of arid ecology research over the past 20 years.

Journals

Papers produced by, and with, Arid Recovery have been published in a range of journals. Journals can be assessed by their impact factor, a measure of the mean number of citations for papers published within that journal over the past two years. Typically, journal impact factors above 10 are considered excellent, while those around three and above are considered good. On average, journal impact factors are less than one. The mean impact factor of the journals in which Arid Recovery has published is 2.7, with the highest journal impact factor of 10.7 (*Biological Reviews*).

Another measure of scientific journal prestige is the SCImago Journal Rank. The calculation for this indicator is much more complex than for impact factors, which means that it is considered by some to be less biased (in particular, journal impact factors tend to be skewed by one or a small number of influential papers that attract a disproportionate amount of attention or citations). The SCImago Journal Rank allows journals from the same field to be categorised into quartiles (Q1, Q2, Q3, and Q4) of 'prestige', where Q1 journals are the top-ranked (or most prestigious) 25% of journals in that field. In total, 51 Arid Recovery papers (48%) are published in Q1 journals, with a mean journal *h*-index of 157. All except two of the remaining papers are published in Q2 journals, indicating that Arid Recovery is publishing consistently high-quality work.

Awards

Arid Recovery's research has been recognised in a number of awards. Most recently, two research programs were listed as finalists in the 2020 Eureka Awards, the 'Oscars' of Australian science.

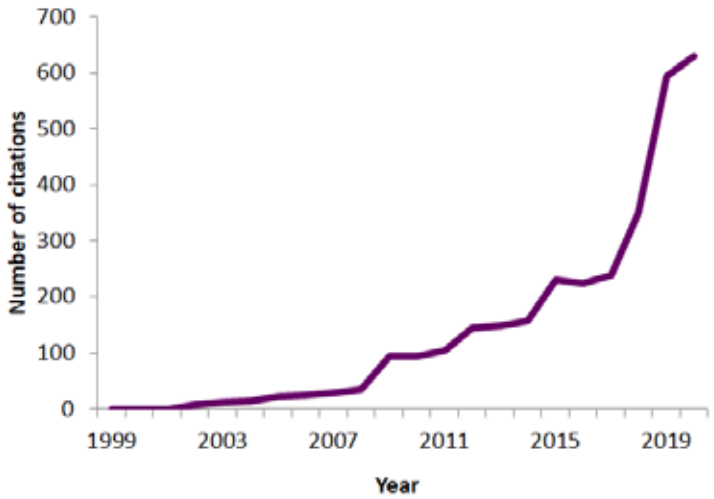


Figure 11. *Number of citations for Arid Recovery papers in each year.*

Impact on policy and management

Ultimately, Arid Recovery research aims to improve policies and practices in the conservation of threatened species and arid ecosystems. There are many examples of our positive impact on policy and management.

In particular, the development of the signature 'floppy top' cat-proof fence design that is used at the 123 km² Arid Recovery Reserve has been a key element of threatened species management in Australia. At least 23 other fenced reserves in Australia now use this design. Those 23 reserves represent 85% (58,000 ha) of Australia's network of 'safe havens' for threatened mammals, and there is at least one of these reserves in every mainland state and territory. Arid Recovery is widely recognised in the industry for this expertise, and we regularly advise on aspects of fence design to new and existing fenced safe haven projects.

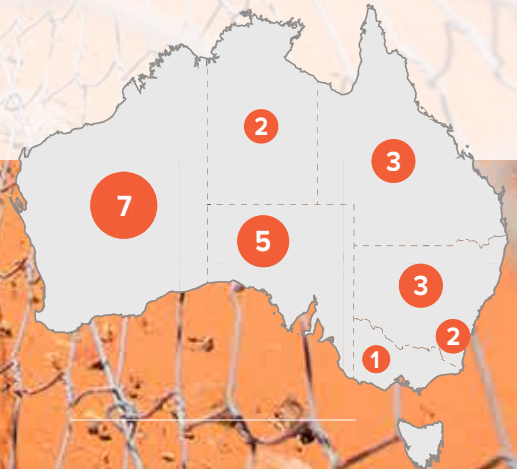
Arid Recovery also conducted and published the first management trials of Eradicat® feral cat baits in South Australia. Eradicat® baits are now used across more than 5,000 km² of national park and adjoining properties in the South Australian government's decades-long Bounceback program, which has enabled yellow-footed rock-wallabies to recover, and western quolls and brushtail possums to be reintroduced to the state.

Arid Recovery was a significant research and end-user partner on the National Environmental Science Program's (NESP) Threatened Species Recovery Hub from 2015 to 2021, hosting three field research projects and contributing to five nationwide collaborations. We are also partners in the new NESP Resilient Landscapes Hub, which will provide applied research to inform management of Australia's terrestrial and freshwater habitats.

We are thought-leaders in the management of populations of reintroduced species within fenced reserves, particularly with the challenging issues of overabundance of the reintroduced species, and, increasingly, drought and climate change impacts.

Application of the Floppy Top fence design

23 reserves 85% (58,000ha) of the safe haven network



Impact beyond science and management

One of our goals at Arid Recovery is to raise awareness of arid zone conservation among the broader public, beyond the community of ecologists and conservation professionals. Therefore, while it is important to publish papers and attract attention from the scientific community, we also strive to disseminate our research to a broader audience. Arid Recovery's high-quality research also receives substantial attention from the general public.

Altmetrics (alternative metrics) are non-traditional indices used to measure the impact of scientific research on the general public. Rather than focussing on journal impact factors or number of citations to estimate research impact, the Altmetric Attention Score is calculated based on online attention (e.g. from social media, blogs, and news media) received by published articles. Sources such as news media, blogs, and policy documents contribute heavily to the Altmetric Attention Score, while social media sources contribute less. The significance of these scores differs between journals (in particular, larger journals are likely to have higher readership than smaller journals, which will bias Altmetric scores); however, in general, if an article earns a score of 20 or more, it is likely to have attracted more attention than most other contemporary articles. This metric was introduced only recently; hence, many early publications do not have calculated scores. For papers in the Arid Recovery database with calculated scores, the mean Altmetric score is 24.16, with a top-10 mean of 102.7; the highest-rated paper has a score of 167. This highlights the impact and general interest of research produced by Arid Recovery.

One of the main reasons that Arid Recovery papers have high Altmetric scores is because they receive attention from news media. Figure 12 shows the media coverage from 1998 until 2010; there was a high and steadily increasing level of media coverage across those years. Evidently, this has continued into the Altmetric era.

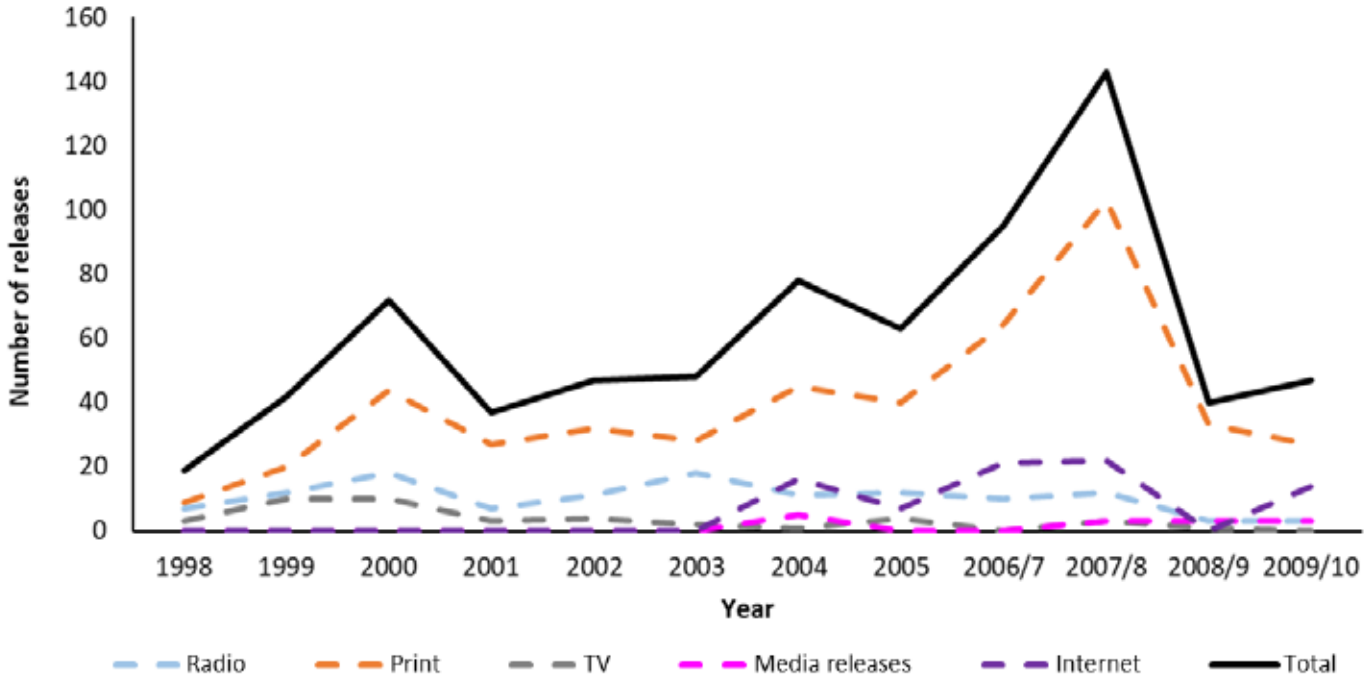


Figure 12. Number of publicity releases about Arid Recovery (radio, print media, television, media releases and internet stories) from 1998 until 2010.

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