Lake Torrens
South Australia

28 August–9 September 2016

Bush Blitz Species Discovery Program

Australian Government
Department of the Environment and Energy

bhpbilliton
Sustainable Communities

EARTHWATCH INSTITUTE

Australian Biological Resources Study

What is Bush Blitz?

Bush Blitz is a multi-million dollar partnership between the Australian Government, BHP Billiton Sustainable Communities and Earthwatch Australia to document plants and animals in selected properties across Australia.

This innovative partnership harnesses the expertise of many of Australia's top scientists from museums, herbaria, universities, and other institutions and organisations across the country.

Abbreviations

ABRS
Australian Biological Resources Study

AD
State Herbarium of South Australia

ANIC
Australian National Insect Collection

CSIRO
Commonwealth Scientific and Industrial Research Organisation

DEWNR
Department of Environment, Water and Natural Resources (South Australia)

DSITI
Department of Science, Information Technology and Innovation (Queensland)

EPBC Act
Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)

MEL
National Herbarium of Victoria

NPW Act
National Parks and Wildlife Act 1972 (South Australia)

RBGV
Royal Botanic Gardens Victoria

SAM
South Australian Museum

Summary

In late August and early September 2016, a Bush Blitz survey was conducted in central South Australia at Lake Torrens National Park (managed by SA Department of Environment, Water and Natural Resources) and five adjoining pastoral stations to the west (Andamooka, Bosworth, Pernatty, Purple Downs and Roxby Downs). The traditional owners of this country are the Kokatha people and they were involved with planning and preparation of the survey and accompanied survey teams during the expedition itself.

Lake Torrens National Park and surrounding areas have an arid climate and are dominated by three land systems: Torrens (bed of Lake Torrens), Roxby (dunefields) and Arcoona (gibber plains). Lake Torrens National Park is located on land that is listed in the Directory of Important Wetlands in Australia in recognition of its importance as an inland saline lake. It is also classified as an IUCN Category VI – Protected Area.

Terrestrial invertebrate fauna are generally poorly sampled in Australia, especially in arid and semi-arid regions, and regions that often show strong seasonality. To date, no comprehensive collections of the insect fauna have been undertaken in the Lake Torrens region of northern South Australia. Vertebrate fauna and vascular plant survey work has been undertaken in this area, but has been concentrated around Roxby Downs and the Olympic Dam mine. A Biological Survey of South Australia was carried out across the stony deserts of South Australia between 1994 and 1997, which included parts of the current study area (Arcoona Plateau – west of Lake Torrens) (Brandle, R., 1998).

Despite the early spring conditions, including a number of rainy days, 944 species were recorded during the Bush Blitz. At least 341 of these species are thought to be new records for the study area and, among these, 42 may be new to science (11 bees, 18 jumping plantlice, 5 spiders, 4 isopods, 3 stygofauna and 1 liverwort). One threatened bird species was recorded—Thick-billed Grasswren (*Amytornis modestus*) is listed as Vulnerable under the EPBC Act. Six state-listed plant species were recorded, among which Sandalwood (*Santalum spicatum*) is listed as Vulnerable.

Some highlights of this Bush Blitz included:

- two sightings of Horsfield's Bushlark (*Mirafra javanica*)—new records for this area and a significant range extension for this bird species
- the collection of a single specimen of an interesting or aberrant colour form of the Barking or Thick-tailed Gecko (*Underwoodisaurus milii*)
- the collection of over 220 oniscidean isopod specimens, including four putative new species (no information had been recorded previously on the occurrence of oniscidean isopod species in the study area)
- new records for 32 vascular plant taxa and eight cryptogams (1 bryophyte, 3 cyanobacteria, 4 algae) in the study area and the collection of a putative new species of aquatic liverwort
- records of 87 native bee species (indicating a high diversity of native bees) and the discovery of a number of putative new species, including a new species of teddy bear bee
- new records for 22 species of jumping plantlice, 18 of which are putative new species.

The principle consideration for land management in the area is the potential impact of restocking some sections following the almost complete absence of stock for a lengthy period. The impact will depend on stocking levels and effective management. Without baseline information on the biodiversity of much of

the area from prior to destocking these impacts may be difficult to gauge, particularly as the recent Bush Blitz was conducted following a relatively good winter (i.e. high rainfall). Other management priorities could include protection of threatened or rare species' habitat (e.g. Spiny Lignum (*Duma horrida* subsp. *horrida*) and Thick-billed Grasswren (*Amytornis modestus*)) and management of pest and weed species.

Of the 30 weed taxa recorded on the Bush Blitz, five are highlighted for control. The remaining 25 are considered to be of low concern, but should be monitored, with any significant population spread or increase being noted and advice sought from Natural Resources SA Arid Lands on feasibility and methods of control. Three pest animal species were recorded (Cat, House Mouse and Rabbit). That no foxes were recorded, while dingos were recorded is of interest, possibly indicating that long-term destocking, and subsequent lack of active management, have allowed dingos to persist in the area for some years.

Contents

Introduction

This is a report for the Bush Blitz program, which aims to improve our knowledge of Australia's biodiversity. Bush Blitz is an initiative of the Australian Government, through the Australian Biological Resources Study (ABRS), in partnership with BHP Billiton Sustainable Communities and Earthwatch Australia. Bush Blitz aims to:

- promote, publicise and demonstrate the importance of taxonomy through species discovery
- undertake a national species discovery program
- support the science of taxonomy in Australia through training of students and early career researchers, and by providing grants for species description and resolution of taxonomically problematic, nationally important groups
- promote partnerships between scientific institutions, government, industry and non-government organisations
- inform reserve managers and other stakeholders of the results of Bush Blitz projects.

The Lake Torrens Bush Blitz

This Bush Blitz took place in early spring, in late August to early September, 2016. Weather conditions were mild and it rained for a number of days at the start of the expedition. Conditions were good for surveying and collecting most of the groups of organisms targeted.

Lake Torrens National Park and the surrounding pastoral properties lie west of the Flinders Ranges, about 65 km north of Port Augusta. Lake Torrens National Park was selected as a Bush Blitz location for two reasons: CSIRO modelling showed it to be, biologically, one of the least well-known areas in South Australia (particularly the lake bed itself); and, the traditional owners, the Kokatha, invited Bush Blitz to mount an expedition on their traditional lands.

Bush Blitz provided the logistical coordination and overall leadership for the survey. Coordination and participation were also provided by Earthwatch Australia and BHP Billiton, respectively. Assistance was provided by staff from SA Department of Environment, Water and Natural Resources (DEWNR) – Arid Lands NRM. The South Australian Museum (SAM) and State Herbarium of South Australia (AD) were the host institutions for this Bush Blitz, providing the core group of personnel and accessioning the specimens into their collections. Experts from the following organisations also conducted field and laboratory work:

- Flinders University
- University of Adelaide
- Queensland Museum
- Royal Botanic Gardens Victoria (RBGV)

Acknowledgements

The Bush Blitz team comprised Brian Hawkins, Karl Newport, Kate Gillespie, Megan Donaldson, Jo Harding and Sue Fyfe. They would like to thank all participants, staff of SA Department of Environment,

Water and Natural Resources (DEWNR) – Arid Lands NRM who provided advice and facilitated access to the reserves, the helicopter company (Helivista) and pilots Neil Strang and Tim Anderson, and caterer Robbie Bayliss. Thanks to Bosworth Station (Max Greenfield), Pernatty Station (Owner—Colin Greenfield, Managers—Joel and Edith Venables), Arcoona Station (Adam Willis) and the Kothaka people.

The ABRS acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present. The traditional owners of this country are the Kokatha people, who were involved with planning and preparation of the survey and accompanied survey teams during the expedition itself. Special thanks go to the following Kokatha participants: Barbara Amos, Max Reid, Michael Starkey, Michael Turner, David Hunter (Kokatha Pastoral) and the Kokatha rangers. Thanks also to Bill Ryan (Kokatha General Manager) and Alan Wallace.

The enthusiastic and good humoured field assistants from BHP Billiton and their coordinators, Cassandra Nichols, Justin Forster and Bruce Paton (Earthwatch Australia), are gratefully acknowledged. BHP Billiton employees on the trip were Aimee Bennett, Candice Burvill, Ingrid Flemons, John Forsyth, Matthew Kavanagh, Peter Olds, Mary Thatcher and Joshua Gatt.

Reserve overview[1]

Reserve name: Lake Torrens National Park and adjoining stations (Andamooka, Purple Downs, Roxby Downs, Bosworth and Pernatty)

Area: 14,357 km²

Description

The study area has an arid climate and is dominated by three main land systems: Torrens, Roxby and Arcoona. The Torrens land system occurs on the bed of Lake Torrens (which is usually dry, having completely filled only once in the past century) and consists of the salt-crusted lake bed, fringes of salt-tolerant shrubs, and lunettes (lake-edge crescent dunes) of wattle and hopbush. The Roxby land system comprises extensive dunefields over a calcareous plain. The Arcoona land system consists of undulating tablelands dominated by gibber (rock- and pebble-littered plains). Andamooka Homestead is located near the boundary between the Roxby and Arcoona land systems, with sand dunes to the west and stony tablelands to the east.

Lake Torrens National Park, the boundary of which follows the shoreline of the lake, was declared in 1991. Since then, there has been little active management, apart from occasional counts of nesting waterbirds (in particular, Banded Stilts (*Cladorhynchus leucocephalus*)) and control of predators. The low level of management is due to a focus on other parks within the district that have visitor management priorities, such as the highly visited Ikara-Flinders Ranges National Park, which is an icon park of South Australia, and Vulkathunha-Gammon Ranges National Park. The Lake Torrens National Park is located on land which is listed in the Directory of Important Wetlands in Australia under the name *Inland Saline Lakes*. The national park is classified as an IUCN Category VI protected area.

The pastoral leases for the stations of Andamooka, Roxby Downs and Purple Downs were acquired by BHP Billiton approximately 10 years ago as environmental buffers for the mining operations at Olympic Dam. At that time, the stations ceased to be managed as pastoral properties. Apart from some agistment of stock from neighbours, there has been little grazing on these properties for the last 10 years. Recently BHP transferred the leases for these three stations to the traditional owners, the Kokatha people, who have established a base at Roxby Downs station (not to be confused with Roxby Downs town) and begun preparing the stations for use as conservation-oriented pastoral properties.

Bosworth and Pernatty Station are managed as pastoral stations. There is an active mine on Pernatty Station, in North Eliza paddock (northern end of property).

[1] Information sourced from https://www.protectedplanet.net/lake-torrens-national-park and https://en.wikipedia.org/wiki/Lake_Torrens_National_Park

Methods

Taxonomic groups studied and personnel

A number of taxonomic groups were selected as targets for study. Table 1 lists the groups surveyed and the specialists who undertook the fieldwork.

Table 1 Taxonomic groups surveyed and personnel

Group	Common name	Expert	Affiliation
Vertebrata	Vertebrates	David Armstrong	DEWNR
		Graham Armstrong	Consultant/SAM
General invertebrates and salt lake fauna		Peter Hudson	SAM
Hymenoptera	Bees	Remko Leijs	SAM
Stygofauna	Subterranean fauna	Remko Leijs	SAM
Hymenoptera	Bees, wasps	Ben Parslow	Flinders University
Hemiptera	Jumping plantlice	Gary Taylor	University of Adelaide
Arachnida	Spiders	Renan Santana	Queensland Museum
		Sophie Harrison	University of Adelaide
Isopoda	Oniscidean isopods	Mohammad Javidkar	University of Adelaide
Gastropoda	Snails	Tony Robinson	SAM
Vascular and non-vascular plants	Flowering plants, cyanobacteria, algae, bryophytes, lichen and fungi	Peter Lang	AD
		Helen Vonow	AD
		Chris Brodie	AD
		Juergen Kellermann	AD
		Chelsea Tothill	AD
Fungi		Teresa Lebel	RBGV

The Bush Blitz team would also like to acknowledge the contributions of the following people:

- Terry Reardon and Graham Medlin, from SAM, for assistance with micro bat call identification and owl pellet dissection and analysis respectively.
- Eric Matthews (Coleoptera specialist), Mike Moore (Lepidoptera specialist), Rodney Hutchinson (ant specialist) and John Weyland (ant specialist), all from SAM, for assistance with general invertebrate identification. Steve Richards also assisted with Odonata identification.
- Erin Fagan-Jeffries, from the University of Adelaide, for assistance with Hymenoptera identification.

- Katja Hogendoorn from the University of Adelaide for assistance with native bee identification.
- Bob Baldock (aquatic plant identification), Robyn Barker (vascular plant identification), W.R. (Bill) Barker (vascular plant identification), Graham Bell (bryophyte and lichen identification), Pamela Catcheside (fungi identification), Ainsley Calladine (data processing), R.J. (Bob) Chinnock (vascular plant identification, Cactaceae), Laurie Haegi (vascular plant identification), Martin O'Leary (plant identification, *Acacia*, *Eucalyptus*) and Carolyn Ricci (aquatic plant identification), all from the State Herbarium of South Australia for their assistance with identification and report writing.
- Michelle Casanova, from the RBGV, for assistance with charophyte identification.
- Glen McGregor, from Water Planning Ecology, DSITI, QLD, for assistance with cyanobacteria identification.
- Kelly Shepherd, from the WA Herbarium, for assistance with vascular plant identification (samphires).

Site selection

All terrestrial scientists surveyed two standard survey sites selected by Bush Blitz by using modelling prepared by CSIRO. Each standard survey site was centred on a point (permanently marked), but the actual area surveyed varied between taxa. Standard methodologies were used to sample these sites.

The use of standard survey sites provides a unique opportunity to examine broad-spectrum biodiversity. Among other benefits, this will enable Bush Blitz's partners at CSIRO to test assumptions that underpin many conservation decisions (e.g. assumptions about relationships between the diversity of different taxa). It will also allow comparisons between sites, and establish a basis for future monitoring by reserve managers.

Apart from standard survey sites, site selection and collection methods were left to the discretion of the individual scientist. Site selection depended largely on access, suitability for trapping and time restrictions.

Further considerations included:

- Vertebrate site selection was restricted by limited reptile activity during the expedition (late winter-early spring) and staff numbers available for checking traps over a large area. Therefore two trap sites were established in close proximity to the base camp at Andamooka in the two dominant habitat types.
- Salt lake invertebrate fauna survey site selection was guided by the availability of access tracks and depended on clearance from traditional owners. Lake Torrens, Mountford Spring Island, Willaroo Lagoon and Shell Lagoon were targeted.
- General insect (dragonflies, damselflies, beetles, butterflies, moths and ants) collecting sites were selected on the basis of reasonable proximity to the Andamooka base camp, so they could be monitored easily, and ensuring that they reflected the two major landforms of the survey area (Roxby Dune Formation and Arcoona Tableland). Opportunistic sweeping and trapping occurred at other random locations.
- Wasp and bee sites were selected to enable sampling of a maximum range of vegetation types across all properties. For bees, sites with a large number of flowering plants were selected.

- Stygofauna sampling sites depended on access to existing pastoral wells and groundwater observation bores (which were assessed for suitability for stygofauna sampling from the South Australian Government drillhole database, WaterConnect). Additionally, some existing springs are known to occur on Lake Torrens.
- Jumping plantlice surveys targeted different habitats, concentrating on areas of diverse vegetation types.
- Spider sites were selected using modelling that allowed comprehensive sampling, including a variety of habitats, while not losing excessive time in transit.
- Isopod sampling sites were selected based on the habitat type, including sand dune fields, creeks, the bed of Lake Torrens and gibber plain.
- Snail site selection was difficult, with much of the area being considered 'land snail unfriendly' habitat. Sites were selected that looked likely to include snail habitat. Stygofauna field scientists looked for aquatic snails at the spring survey sites.
- Vascular plants and fungi site selection was based on environmental characteristics that suggested the best chance of finding new or unreported taxa.

Site locations were recorded using global positioning systems.

Survey techniques

A standard suite of survey techniques was used:

- **Vertebrate** collection was carried out using pitfall traps. Trap sites consisted of a line of six cylindrical pitfall holes. These were 10 m apart, along a low 60 m wire netting 'drift fence' to guide small animals into the pitfalls. Six funnel traps were also set along the fence, three on each side, between the pitfall holes. Fifteen Elliot traps were set at approximately 10 m intervals in a line parallel to the pitfall line and about 20 m away.

  Once the trap sites were established, as much of the survey area as possible was covered by vehicle, using active searching and observation to obtain widely dispersed vertebrate records. Headtorch spotlighting was also used on the few occasions when evening conditions were suitably warm. Most of the records obtained on the expedition were through opportunistic observation rather than standardised sample sites.

  Anabat Express recorders were used to record bat calls at several locations from the Andamooka homestead along the main track to Roxby Downs homestead. A quantity of Barn Owl (*Tyto alba*) pellets were collected from the old Roxby Downs homestead.
- **Salt lake invertebrate** collection was opportunistic. Habitats were searched for evidence of burrowing activity and burrows were excavated. Micropitfalls were installed at sites but all were flooded and were therefore of no use.
- **General insect** (dragonflies, damselflies, beetles, butterflies, moths and ants) collection was carried out using pitfall traps (both macro invertebrate pits and ethanol-filled micropits); malaise traps; light sheets; and general opportunistic searching (e.g. sweeping and beating vegetation, searching carcasses and around burrows).
- **Wasp and bee** collection involved use of flight intercept traps, sweep-netting, direct aspiration off vegetation, active collecting at a light sheet and a vehicle-mounted insect net for parasitoid wasps. Two types of flight intercept trap were used: a Townes-style malaise trap and SLAM vane trap. These were deployed in natural flight corridors around flowering plants. The traps were deployed for an average of seven days at a site before being relocated.

Active searching and sweep-netting of wasps at flowering plants and among a variety of vegetation types was also carried out, as well using a vehicle-mounted insect net for collecting startled and flying insects during transit.

Bees were collected individually using a hand net, by sweep-netting of specific plants, using blue vane traps, or using a vehicle net. Plant species on which the bees were collected were recorded.

- **Stygofauna** collection involved sampling of bore water/wells using a weighted plankton net with a diameter to fit the borehole. The nets were used to filter the whole water column at least three times. The shallow wells were sampled using a large weighted plankton net. Hyporheic waters near springs were sampled using the Karaman–Chapui method of digging a small hole in the creek bed, and scooping subsurface water into a plankton net. Additionally, springs vents and outflows were sampled using a small hand net.
- **Jumping plantlice** were collected by sweeping one particular plant species at each site—plantlice tend to be host specific so recording of the host plant is critical.
- **Spider** collection, for burrow-dwelling mygalomorph spiders, involved searching by eye for burrow lids or open burrow entrances, and then excavating the burrow. This was done by inserting a flexible stick or piece of grass into the burrow to detect its layout, then creating a trench-like excavation alongside the burrow. The burrow was then carefully pared away until the spider at the bottom was revealed. Pitfall traps were erected to catch wandering spiders. The traps consisted of plastic buckets dug into the ground. For most araneomorphs, the easiest method of collection was foraging—peeling of bark, and searching on trees, bushes, grasses, and through leaf litter. Pooters were also used to collect specimens.
- **Isopods** were collected along 100 m transects by shuffling stones and leaf litter, and by searching around tree trunks etc., using a short hand shovel. Some other specimens were collected using general pitfall traps set by other invertebrate scientists. The specimens were then preserved in 100% ethanol for molecular/morphological study.
- **Snail** collection of the larger land snails involved looking for dead shells on the ground at collection sites. Similarly, snails down to several millimetres in length were collected by raking of leaf litter under trees and by searching the underside of rocks, logs and bark for possible attached aestivating snails or dead shells. Following discovery of dead shells, searching deep into rock piles or digging around the base of bushes sometimes yields live material.

  Aquatic snails can also be found as dead shells along the strand lines of swamps and drainage lines and can be found live in free water, among algae on mud at the bottom.
- **Plant** specimens were collected when a taxon was encountered in suitable condition. Collection also involved taking leaf tissue subsamples from plants. Leaves from a single branch were collected into empty paper tea bags, and then stored in containers of silica gel for rapid desiccation. These vouchered samples will be stored at the State Herbarium for use with genetic and other molecular research projects, such as DNA sequencing for phylogenetic analyses, or other tissue analyses.

  Soil-crust lichens were collected with the associated soil to which they were attached.

  Institutional priorty groups were also collected, among them *Acacia* species, and the families Malvaceae, Solanaceae, Myoporaceae, Zygophyllaceae, Gramineae (Poaceae), Compositae (Asteraceae), Chenopodiaceae (particularly samphires), Goodeniaceae, plus weeds, lichens, bryophytes and aquatic plants.
- **Fungi** were collected incidentally during visual surveys of plants. Specimens were photographed *in-situ*, before being carefully dug out of the soil or cut off timber (with a small portion of substrate) using a penknife.

- **Galling organisms** were collected from chenopod plants. Samples of galled chenopods were collected into large plastic bags and kept as cool as possible. The galls yielded both fungal material and insects (usually the inducers of the gall). From the gall, samples of fungal layers were taken and placed in 1.5 ml Eppindorf tubes with silica gel (to dry). To obtain the insect specimens, back at the homestead 20 galls of each species found were carefully dissected and larvae, pupae, and emerging adults stored in small plastic vials in 80% ethanol. A further 10–20 galls were placed, unopened, into 25 ml plastic vials in 80% ethanol for later examination. The remainder of galled material was kept in plastic bags for 2–5 days to collect emerging adults of gall-midges (*Asphondylia* species) and parasitoid wasps which were then placed in 80% ethanol.

Identification

The specimens taken were identified using available literature and the holdings of museums and herbaria. Fauna specimens, vouchers and tissues were deposited with the South Australian Museum. All plant specimens and tissue collected were lodged in the State Herbarium of South Australian, where field identifications were confirmed or updated by taxonomists. All specimen data are available through the Atlas of Living Australia.

Results

Locational data for all flora and fauna records are available to land managers. At least 341 species were new records for the study area (some results are yet to be finalised), including 42 putative species new to science—these await formal identification. One threatened animal species was observed and one threatened plant. Three exotic or pest animal species and 30 weed species were also recorded. Table 2 provides a summary of the flora and fauna records for the reserve.

Table 2 Summary of flora and fauna records

Group	Common name	Number of species recorded	Species newly recorded for study area	Putative new species	Threatened species*	Exotic and pest species**
Mammalia	Mammals	16	0	0	0	3
Aves	Birds	78	1	0	1	0
Reptilia	Reptiles	36	0	0	0	0
Amphibia	Frogs and toads	1	0	0	0	0
Hymenoptera	Ants	19	1	0	0	0
Hymenoptera	Bees	87	79	11	0	0
Hymenoptera	Wasps	143	143	0	0	0
Lepidoptera	Butterflies and moths	17	0	0	0	0
Diptera	Flies	4	0	0	0	0
Coleoptera	Beetles	46	3	0	0	0
Hemiptera	Jumping plantlice	22	22	18	0	0
Orthoptera	Grasshoppers and crickets	1	0	0	0	0
Odonata	Dragonflies and damselflies	5	0	0	0	0
Arachnida	Spiders and scorpions	40	38	5	0	0
Crustacea	Oniscidean isopods	9	9	4	0	0
Crustacea	Other crustaceans	2	2	2	0	0
Gastropoda	Snails	4	2	0	0	0
Turbellaria	Free-living flatworms	1	1	1	0	0
Magnoliophyta	Flowering plants	354	32	0	1	30
Pinophyta	Conifers	1	0	0	0	0

Group	Common name	Number of species recorded	Species newly recorded for study area	Putative new species	Threatened species*	Exotic and pest species**
Tracheophyta	Ferns and fern allies	3	0	0	0	0
Bryophytes	Liverworts and mosses	16	1	1	0	0
Fungi	Fungi	18	0	0	0	0
Lichens	Lichens	10	0	0	0	0
Algae	Algae	4	4	0	0	0
Cyanobacteria	Cyanobacteria	7	3	0	0	0
Total		**944**	**341**	**42**	**2**	**33**

* Species listed as threatened under the Commonwealth EPBC Act or an equivalent listing under the National Parks and Wildlife Service Act 1972 (South Australia)
** Includes native species that are at times pests or are exotic to this region.

Species lists

Lists of all species recorded during the Bush Blitz are provided in Appendix A. Species lists were compiled using data from participating institutions.

Some specimens have been identified only to family or genus level. This is partly because identification of specimens is very time-consuming, with detailed microscopic examination needed in many cases. Also, some groups are 'orphans': currently no experts are working on them, or are available to work on them, and the taxonomic literature is out of date; species-level identification is not possible for these groups. Unidentified Bush Blitz specimens are held in institutional collections where they are available for future study. Collections hold many such specimens, among them species not yet described (i.e. unnamed species) as well as described species that have not been identified. For example, ANIC holds tens of thousands of unidentified specimens. Specimens often wait decades before the resources become available for their study. A key component of Bush Blitz is the funding of studies of specimens collected on Bush Blitz surveys.

Nomenclature and taxonomic concepts used in this report are consistent with the Australian Faunal Directory, Australian Plant Name Index, Australian Plant Census, AusMoss, Catalogue of Australian Liverworts and Hornworts, Checklist of the Lichens of Australia and its Island Territories, and the Interactive Catalogue of Australian Fungi.

Discussion

Putative new species

Here we use the term 'putative new species' to mean an unnamed species that, as far as can be ascertained, was collected for the first time during this Bush Blitz. It is confirmed as a new species once it is named and its description is published. Specimens collected during the Bush Blitz also include unidentified taxa that are already known from museum and herbarium collections—these are not counted as putative new species.

Fauna

Invertebrates

Bees

At least 11 putative new species of bee were collected on this expedition. These species do not fit any of the existing species descriptions or available species images on PaDIL. It is highly likely that further examination of unidentified native bee specimens will result in the recognition of additional new species.

Wasps

Not all recognised wasp morphospecies could be identified conclusively as the authors did not have access to some keys and type specimens. Following further investigation, new species are expected, especially in the species-rich group, Chalcidoidea.

Jumping plantlice

Of the 22 species of Psylloidea collected, only four could be assigned confidently to described species, the remaining 18 are putative new species in six genera and three families. Of the remaining morphospecies, most are likely to be new. Other notable discoveries include new species of psyllids on *Eremophila*, several undescribed species on *Dodonaea* and 12 undescribed species of *Acizzia* from a suite of hosts.

Spiders

Five putative new spider species from four genera were collected on the expedition. Four are araneomorphs, and one a mygalomorph. The number of new species is likely to be much higher; however without molecular data and/or mature males it is very difficult to be sure. For example, several female specimens of *Blakistonia* were found. While it can be stated confidently that they are not conspecific with the nearest *Blakistonia* species recorded (Wilpena Pound, Flinders Ranges), several species have been described recently based on males only, from remote South Australia. Sequence data are not available for all of these. While it is unlikely that this species is conspecific with any of these males due to the distance (ranging from approximately 200–300 km), this cannot be confirmed in the absence of mature males and/or molecular data.

Isopods

Current morphological investigation suggests that four putative new species of isospods were collected in the study area, including three species of *Buddelundia* (Armadillidae) and one species of *Laevophiloscia* (Philosciidae).

Table 3 Putative new invertebrate species

Family	Species
Bees	
Apidae	*Amegilla* sp.LTRL39
Colletidae	*Hylaeus* sp.LTRL40
Colletidae	*Hylaeus* sp.LTRL41
Colletidae	*Hylaeus* sp.LTRL42
Colletidae	*Hylaeus* sp.LTRL44
Colletidae	*Hylaeus* sp.LTRL46
Colletidae	*Hylaeus* sp.LTRL52
Colletidae	*Hylaeus* sp.LTRL59
Colletidae	*Hylaeus* sp.LTRL61
Colletidae	*Leioproctus* sp.LTRL36 n.sp.
Halictidae	*Lasioglossum* sp.LTRL17 n.sp.
Jumping plantlice	
Aphalaridae	BB_Lake Torrens_*Creiis* sp.1
Aphalaridae	BB_Lake Torrens_*Glycaspis* sp.1
Aphalaridae	BB_Lake Torrens_*Platyobria* sp.1
Aphalaridae	*Blastopsylla* (near) *occidentalis*
Psyllidae	BB_Lake Torrens_*Acizzia* sp.1
Psyllidae	BB_Lake Torrens_*Acizzia* sp.2
Psyllidae	BB_Lake Torrens_*Acizzia* sp.3
Psyllidae	BB_Lake Torrens_*Acizzia* sp.4
Psyllidae	BB_Lake Torrens_*Acizzia* sp.5
Psyllidae	BB_Lake Torrens_*Acizzia* sp.6
Psyllidae	BB_Lake Torrens_*Acizzia* sp.7
Psyllidae	BB_Lake Torrens_*Acizzia* sp.8

Family	Species
Psyllidae	BB_Lake Torrens_*Acizzia* sp.9
Psyllidae	BB_Lake Torrens_*Acizzia* sp.10
Psyllidae	BB_Lake Torrens_*Acizzia* sp.11
Psyllidae	BB_Lake Torrens_*Acizzia* sp.12
Triozidae	BB_Lake Torrens_*Myotrioza* sp.1
Triozidae	BB_Lake Torrens_*Myotrioza* sp.2
Spiders	
Ammoxenidae	*Austrammo* sp. nov. 1
Ammoxenidae	*Austrammo* sp. nov. 2
Gnaphosidae	*Eilica* sp. nov.
Idiopidae	*Aganippe* sp. nov.
Miturgidae	*Elassoctenus* sp. nov.
Crustaceans	
Armadillidae	*Buddelundia*_BB_SP03
Armadillidae	*Buddelundia*_BB_SP05
Armadillidae	*Buddelundia*_BB_SP06
Chiltoniidae	*Chiltoniidae* n. sp. LTRL61
[Order Harpacticoida]	*Harpacticoida* n. sp. LTRL62
Philosciidae	*Laevophiloscia*_BB_SP02
Free-living flatworms	
[Higher taxon Turbellaria]	*Turbellaria* n. sp. LTRL63

Flora

A specimen of the aquatic liverwort *Riella* was collected inadvertently. Only small fragments were discovered in mud during the process of sorting and cleaning material of Characeae collected from a dam. However, one portion with sporophytes was found. This was enough to indicate that this collection represented neither of the two species recorded previously from Australia—*R. halophila* and *R. spiculata*. The calyptra in this specimen is plicate, a feature not seen in either of the known species. Further material is needed to complete a formal identification of the specimen found. As these species are rarely found, due to their minute size and the cryptic and transient nature of the habitat, this may not easily be achieved.

Table 4 Putative new flora species

Family	Species
Liverworts	
Riellaceae	*Riella* sp. nov.

Threatened species

Australia is home to an estimated 580,000–680,000 species, most of which have not been described. Approximately 92% of Australian plants, 87% of mammals, 93% of reptiles and 45% of birds are endemic. Changes to the landscape resulting from human activity have put many of these unique species at risk. Over the last 200 years, many species have become extinct; many others are considered to be threatened, i.e. at risk of extinction.[2]

Fauna

Vertebrates

Birds

The EPBC-listed Thick-billed Grasswren (*Amytornis modestus*) was observed at Andamooka Station in dense shrubs around Burden Hill Dam. This fourth record of the species in the study area, was from approximately 10 km south-east of the nearest previous record at Just In Time Bore. The other two records were some distance away, to the north of Roxby Downs and Andamooka.

Table 5 Threatened vertebrate fauna species

Family	Species	Common name	Status
Birds			
Maluridae	*Amytornis modestus*	Thick-billed Grasswren	Vulnerable (EPBC Act)

Invertebrates

Spiders

While none of the species sighted are listed under the EPBC Act or NPW Act, our current data is an inadequate basis on which to determine whether any species are threatened. Mygalomorphs often have short range endemic distributions, which makes them particularly vulnerable to habitat destruction. Further surveys would need to be carried out over a longer period of time to enable more accurate assessment of the conservation status of these species. In particular, pitfall trapping of male mygalomorph spiders during the first rains in autumn would need to be carried out, and juvenile burrows would need to be carefully noted, to ensure existing populations have healthy levels of recruitment. While smaller *nemesiid* and *Aganippe* burrows were observed during the field trip (surprising for *Aganippe*, given their highly cryptic burrow morphology), no smaller *Blakistonia* burrows were recorded, possibly indicating low recruitment levels.

[2] Chapman, A. D. 2009, *Numbers of Living Species in Australia and the World*, 2nd edn. Australian Biological Resources Study, Canberra.

Flora

Six species of flora recorded are conservation-listed in South Australia.

Sandalwood (*Santalum spicatum*) is listed as Vulnerable in SA as it is harvested illegally for the fragrant properties of its timber. Sandalwood is usually sparsely distributed, occurring as occasional single trees or in small clusters, but it tends to be scattered widely throughout suitable land systems so is probably more common than the numbers encountered might suggest.

Brachyscome eriogona and Western Tarvine (*Gilesia biniflora*) are widely distributed in the arid zone and are probably under-collected due to their ephemeral nature. They are sometimes seen in large numbers in response to good rains. Sand Lily (*Corynotheca licrota*) is typically found in deep sand, often on the crests of dunes, and has a wide range in this habitat in SA. It is probably often overlooked when not in flower and is thus likely to be more common than the limited number of collections suggest. All three species are currently under consideration for de-listing in SA.

Spiny Lignum (*Duma horrida* subsp. *horrida*) was found in the study area in a narrow habitat zone on the west side of Lake Campbell. It is only the second collection of the species from the Gairdner-Torrens botanical region of SA, having been collected once previously from Lake Campbell in 1971. This constitutes a puzzling and extremely disjunct outlier of a species that is otherwise known in SA only from the River Murray floodplain. As such, the Lake Campbell population is a biogeographically significant population of conservation importance and its condition should be monitored. To more fully evaluate its significance, DNA sequencing is needed to investigate the degree of genetic differentiation between the Lake Campbell and the River Murray populations.

The presence of Australian Broomrape (*Orobanche cernua* var. *australiana*) appears to be linked to rain events, but is probably more limited by its parasitic nature and the need to form root connections with specific host species. It was only seen at a single site during the survey. Two voucher specimens were collected. One of these is especially valuable in demonstrating the host relationship, as it was excavated carefully to maintain an intact root connection with the host, in this case an adjacent *Leiocarpa websteri* bush.

Table 6 Threatened and Rare flowering plant species

Family	Species	Common name	Status	Abundance
Asteraceae	*Brachyscome eriogona*		Rare (NPW Act)	Occasional
Hemerocallidaceae	*Corynotheca licrota*	Sand Lily	Rare (NPW Act)	Only three plants seen at a single site
Malvaceae	*Gilesia biniflora*	Western Tar-Vine	Rare (NPW Act)	Occasional
Orobanchaceae	*Orobanche cernua* var. *australiana*	Australian Broomrape	Rare (NPW Act)	Locally abundant; estimated several hundred individual flowering spikes within an area of less than 50 m

Family	Species	Common name	Status	Abundance
Polygonaceae	*Duma horrida* subsp. *horrida*	Spiny Lignum	Rare (NPW Act)	Localised occurrence in narrow zone near lake margin
Santalaceae	*Santalum spicatum*	Sandalwood	Vulnerable (NPW Act)	Only encountered at two sites but may be more common than this suggests

Exotic and pest species

Conservation reserves help to protect Australia's rare and threatened ecosystems and provide refuge for species at risk. Invasive species can have a major impact on already vulnerable species and ecosystems, as well as economic, environmental and social impacts. The inclusion of exotic and pest species records as part of this report is designed to provide land managers with baseline information to assist with further pest management programs.

Fauna

Vertebrates

Three species of pest vertebrates were identified during the Bush Blitz. Cats were observed, predominantly close to abandoned homesteads and infrastructure. The remains of 129 individual mice were identified from owl pellets collected at the old Roxy Downs homestead, indicating this species achieves much higher numbers at certain times. Several dead intact rabbit carcasses were observed, probably indicating recent presence of RHD, Myxoma virus or both. Evidence of the presence of rabbits was found on most islands visited on Lake Torrens.

The absence of fox records, but evidence of dingos, recorded by tracks and traces (a full skeleton in one case) on Andamooka Station south of the Dog Fence, is interesting. It is possible that long term destocking, and subsequent lack of active management of several BHP properties now forming the Kokotha Pastoral Company, has allowed dingos to persist in the area for some years.

Table 7 Pest vertebrate fauna species

Family	Species	Common name	Abundance
Vertebrate			
Felidae	*Felis catus*	Cat	low to moderate
Leporidae	*Oryctolagus cuniculus*	Rabbit	low
Muridae	*Mus musculus*	House Mouse	low

Flora

All weed taxa seen in the study area were collected and documented. Generally, much of the area surveyed was intact, healthy, native vegetation, free of weeds, or had only a few low-impact taxa.

Only 30 weed taxa were recorded, relatively few for such a large area. Twenty-five of these are deemed common and widespread weeds of low concern.

Five weed taxa are highlighted as needing intervention and control. Three are high priority species and declared weeds species in SA—Buffel Grass (*Cenchrus pennisetiformis*), African Boxthorn (*Lycium ferocissimum*) and Prickly Pear Cactus (*Opuntia engelmannii*). These species were present in low numbers, and feasibly could be controlled. These species are known to have negative impacts on native plants and animals.

A further two species were highlighted as medium priority for control—Rosy Dock (*Acetosa vesicaria*) and Common Ice Plant (*Mesembryanthemum crystallinum*). These were also present in low numbers, and feasibly could be controlled. These species are known to have negative impacts on native plants and animals in similar environments.

Other weeds should be monitored and any significant population spread or increase, especially in areas of high traffic, controlled to reduce the possibility of further spread. Advice on feasibility and methods of control for individual taxa should be sought from Natural Resources SA Arid Lands.

Table 8 lists the introduced weeds that were identified.

Table 8 State or national weed species recorded

Family	Species	Common name	Abundance
Flowering plants			
Aizoaceae	*Mesembryanthemum crystallinum*	Common Ice Plant	Locally abundant/rare
Asteraceae	*Centaurea melitensis*	Maltese Cockspur	Locally frequent
Asteraceae	*Pseudognaphalium luteoalbum*	Jersey Cudweed	Frequent
Asteraceae	*Sonchus oleraceus*	Common Sow-Thistle	Five sites (occasional/rare/frequent)
Boraginaceae	*Heliotropium curassavicum*	Smooth Heliotrope	
Brassicaceae	*Brassica tournefortii*	Wild Turnip	Occasional/locally abundant
Brassicaceae	*Carrichtera annua*	Ward's Weed	Occasional
Brassicaceae	*Sisymbrium erysimoides*	Mediterranean Rocket	Patchy/locally abundant
Brassicaceae	*Sisymbrium irio*	London Rocket	
Brassicaceae	*Sisymbrium orientale*	Indian Hedge Mustard	Abundant
Cactaceae	*Opuntia engelmannii*	Prickly Pear Cactus	Locally frequent
Caryophyllaceae	*Gypsophila tubulosa*	Clammy Gypsophila	Occasional/rare

Family	Species	Common name	Abundance
Caryophyllaceae	*Herniaria cinerea*	Herniaria/Rupturewort	Rare
Cucurbitaceae	*Citrullus lanatus*	Bitter Melon	Two plants only
Cucurbitaceae	*Cucumis myriocarpus*	Paddy Melon	
Geraniaceae	*Erodium aureum*	Storks Bill	Occasional
Geraniaceae	*Erodium cicutarium*	Common Storks Bill	Occasional
Malvaceae	*Malva parviflora*	Small-Flowered Marshmallow	Rare
Malvaceae	*Malvastrum americanum*	Malvastrum	
Poaceae	*Cenchrus pennisetiformis*	Buffel Grass	Locally abundant
Poaceae	*Rostraria pumila*	Tiny Bristle-Grass	Four locations (rare/common)
Poaceae	*Schismus arabicus*	Arabian Schismus	Occasional
Poaceae	*Schismus barbatus*	Mediterranean Schismus	Occasional/abundant
Polygonaceae	*Acetosa vesicaria*	Rosy Dock	Locally abundant
Polygonaceae	*Emex australis*	Three-Cornered Jack	Rare
Primulaceae	*Lysimachia arvensis* (*Anagallis arvensis* in SA)	Pimpernel	Single plant seen at two locations
Solanaceae	*Lycium ferocissimum*	African Boxthorn	Single patch (10–15 plants)
Solanaceae	*Solanum nigrum*	Blackberry Nightshade	Frequent
Verbenaceae	*Verbena supina* var. *erecta*	Trailing Verbena	Abundant
Verbenaceae	*Verbena supina* var. *supina*	Trailing Verbena	Occasional/rare

Range extensions

Fauna

Vertebrates

Two sightings of Horsfield's Bushlark (*Mirafra javanica*) were a first for the study area. These were seen along a rocky gully approximately 1 km east of Andamooka homestead and at a trap site established on the gibber plateau 3 km west. These records are significant as the species appears to be on the edge of its range in this location. It is possible that the deep gully with its broken small tree line close to both these records may provide an important habitat for this species in extreme conditions.

Invertebrates

Bees

Since adequate fine-scale distributional data including time-series are not available for native bees in Australia, interpretation of apparent range extensions of bees is difficult. Nevertheless, one species, *Neopasiphae mirabilis*, collected during the Bush Blitz has not been recorded outside Western Australia before. This species is common and widespread in central WA.

Wasps

All recorded Gasteruptiidae species showed range extensions. *Gasteruption quadraticeps* and *Pseudofoenus fallax* ranges increased from Victoria into South Australia and *P. thoracicus* extended further into arid areas of South Australia.

Jumping Plantlice

Four species of psyllid were identified that show considerable range extensions or significant infill in distributions records. These are listed in Table 9.

Spiders

Range extensions for spiders ranged from approximately 30 km for Redback Spider (*Latrodectus hasseltii*), which was unsurprising due to the widespread nature of this genus, to approximately 1700 km for the miturgid species *Argoctenus nebulosus.* A total of seven species of spider were identified that show considerable range extensions.

Isopods

Until now, no information has been documented on the occurrence of oniscidean isopods in Lake Torrens National Park and the adjoining areas, and the fauna are poorly known in the arid region of South Australia. For the genera *Buddelundia* and *Laevophiloscia*, just one species of each was recorded previously in South Australia—*B. albinogrisescens* (Adelaide, Murray Darling Basin, S Gulfs, SE coastal) and *L. lowryi* (Wilson Bluff, Nullarbor). *Porcellionides pruinosus* (Murray-Darling Basin, S Gulfs) and *P. sexfasciatus* (S Gulfs) have also been identified from South Australia. The Bush Blitz collections showed clearly that the diversity of the oniscidean isopods is much greater than was recorded formally for South Australia. As neither of these species was identified in the collections from Lake Torrens and adjoining areas, no range extension at species level can be provided. At genus level, however, a range extension of approximately 490 km to the north of Adelaide, 820 km to the north-east of Wilson Bluff (Nullarbor, SA), and 530 km to the north-west of the Murray-Darling Basin (SA) can be recorded for the genera *Buddelundia*, *Laevophiloscia* and *Porcellionides,* respectively.

Flora

Significantly, 32 vascular plant taxa and eight cryptogams (1 bryophyte, 3 cyanobacteria, 4 algae) were recorded from the study area for the first time. Range extensions were evaluated by comparing the list of new taxon records for the study area with their distributions displayed on the ALA, using reliable specimen-based records. Situations in which the nearest ALA record was 150 km or more away were deemed to be a significant infill or extensions to the known range.

Only two terrestrial vascular plants fitted this category—a native, Sand Lily (*Corynotheca licrota*), and one weedy alien, Buffel Grass (*Cenchrus pennisetiformis*).

The other range extensions were all for aquatic plants, which, inherently, have more fragmented distributions due to the patchy distribution, both spatially and temporally, of water bodies in the arid zone. *Callitriche,* a semi-aquatic vascular plant, was represented by vegetative material only and could not be identified with certainty. There is a chance that it may not be a native species, but it is still of significance even at genus level.

The remaining plants are seven taxa that may be referred to loosely as 'algae' (Chlorophyta, charophyta and cyanobacteria) and an aquatic liverwort (*Riella*). It is not surprising that the survey has expanded the known distributions of these species. Such taxa tend to be relatively under-represented in herbaria due to there being fewer specialists studying these groups and because these organisms are less amenable to the standard sampling, collection and curation methods usually employed in general biological surveys. The Bush Blitz survey provided an opportunity to help redress this imbalance.

Table 9 Range extensions

Family	Species	Comments
Birds		
Alaudidae	*Mirafra javanica* (Horsfield's Bushlark)	Observed 3 km east of Andamooka homestead, approximately 100 km from the nearest known record
Bees		
Colletidae	*Neopasiphae mirabilis*	First record outside of Western Australia; previously recorded more than 1540 km away in Credo Conservation Park (WA)
Wasps		
Gasteruptiidae	*Gasteruption quadraticeps*	Recorded from Victoria, new record for South Australia; only single male collected
Gasteruptiidae	*Pseudofoenus fallax*	Widely distributed through eastern Australia; new record for South Australia; only males collected
Gasteruptiidae	*Pseudofoenus thoracicus*	New record for Andamooka Station; found Australian wide; only males collected

Family	Species	Comments
Jumping plantlice		
Aphalaridae	*Anoeconeossa communis*	Infill in distribution records (1,500 km from W; 500 km from E)
Psyllidae	*Acizzia nestor*	Infill in distribution records (1,500 km from W; 500 km from E)
Triozidae	*Myotrioza flindersiana*	Range extension (120 km from NE)
Triozidae	*Myotrioza gawlerensis*	Range extension (250 km from SW)
Spiders		
Araneidae	*Argiope protensa*	60 km range extension
Araneidae	*Austracantha minax*	No ALA records available for this species; closest *Austrocantha* sighting (*Austracantha minox*) approximately 300 km away
Corinnidae	*Nyssus coloripes*	100 km range extension
Desidae	*Badumna insignis*	200 km range extension
Miturgidae	*Argoctenus nebulosus*	Only other record on ALA is from Tasmania
Miturgidae	*Miturga gilva*	160 km range extension
Theriididae	*Latrodectus hasseltii*	30 km range extension
Plants		
Characeae	*Chara preissii*	Significant infill in known distribution; not otherwise known in SA based on ALA collections, however, Michelle Casanova (pers. comm., 2016) has seen material from several locations in southern SA, the northernmost being Thorndon Park Reservoir (NE of Adelaide) and, on this basis, the nearest record would still be approx. 450 km away
Charaeae	*Nitella lhotzkyi*	Significant infill in known distribution; only known in SA from ALA collections in Adelaide area; wide distribution in Australia and probably under-collected; Michelle Casanova (pers. comm., 2016) reported occurrences of this species from as close as the Gawler Ranges, but that still leaves this as a significant extension
Hemerocallidaceae	*Corynotheca licrota*	Significant infill in known distribution which has a major gap that encompasses most of arid SA and extends into NW of NSW and adjoining areas of Qld; approx. 200 km NE from nearest collection (between Lake Acraman and Lake Gairdner).

Family	Species	Comments
Nostocaceae	*Nostoc commune*	Significant infill in known distribution; approx. 150 km NW from nearest collection (Bunyeroo Gorge, Flinders Ranges); likely to be highly under-collected
Oedogoniaceae	*Oedogonium* sp.	The first collections from the arid zone of SA; a significant infill, over 480 km NNW from nearest collection (Adelaide)
Oscillatoriaceae	*Oscillatoria* sp.	Significant range extension; only represented on ALA by records from coastal Queensland
Phormidiaceae	*Phormidium* sp.	Significant infill in known distribution; approx. 460 km N from nearest record (Kangaroo Island)
Riellaceae	*Riella* sp.	Significant infill in known distribution; approx. 230 km SSE from nearest record (Anna Creek Station, S of Oodnadatta)

Other points of interest

Fauna

Vertebrates

Although there was little new, outstanding or unexpected in the vertebrates found or seen in the study area, the specimens and genetic samples obtained from previously sparsely surveyed sections are of significant research value. Despite the weather being a little too cool and early in the season for many reptiles to be active, a considerable proportion of the species already known were recorded.

In total 328 bird records (78 species), 154 reptile records (36 species) and 73 mammal records (13 native species, including 5 bats, 3 introduced) were collected. Many of these records were of multiple individuals such as flocks of birds, numerous bat calls or total numbers of geckos or skinks found under building debris at abandoned homesteads. At one site, 13 Central Bearded Dragons (*Pogona vitticeps*) were removed from a disused underground tank.

Currently the principle consideration for land management in the area is the potential impact of restocking some sections following the virtual absence of stock for a lengthy period. Obviously this will depend on stocking levels and effective management. Without baseline information on the biodiversity of much of the area from prior to destocking these impacts may be difficult to gauge, particularly as the recent Bush Blitz was conducted following a relatively good winter.

Of particular concern is the Thick-billed Grasswren (*Amytornis modestus*). At both sites on Andamooka Station, in particular, it appears to be dependent on denser vegetation near watering points (dams), which would be expected to suffer high impact from watering stock. It seems likely that similar habitats near other watering points within the area could support this species. It would be valuable to undertake a targeted survey for this species at such locations and carry out on going monitoring over future years to assess these impacts.

The value of the records collected during the Bush Blitz are in providing an improved knowledge of species distribution within the area, and in the genetic samples collected. For example, of the 159 records of Sudell's Frog (*Neobatrachus sudellae*) known prior to this survey, only 22 of these were specimens, with about half collected well before the advent of tissue sampling for population and taxonomic studies. Others specimens were attributed to reputable sources but, due to their age, genetic samples may not have been collected. These include collections by M. J. Tyler in 1981 and a hand full by T. D. Schwaner on an unknown date, but definitely before 1987. The most recent specimen was collected in 1996. Interest in obtaining the recent Bush Blitz samples has already been expressed by researchers at the WA Museum. In total 87 specimens were collected (3 bird, 3 frog, 10 mammal and 71 reptile), with genetic samples collected from most, as well as tail tip specimens of several road-killed larger lizards which were not suitable as entire specimens. Skulls of larger animals (3 Red Kangaroo, 1 Dingo), and over 100 Barn Owl pellets were also collected for later analysis.

Invertebrates

Salt lake terrestrial invertebrates

Australian salt lakes have a characteristic terrestrial invertebrate fauna. The taxonomy of some groups such as the tiger beetles (Carabidae: Cicindelinae) and wolf spiders (Lycosidae) is relatively well known, based on both morphological and molecular studies; however, many other groups have received little attention. There are very few collections of the terrestrial invertebrate fauna that live on salt lakes. Prior to 2012, Lake Torrens was only known to have wolf spiders (*Tetralycosa* sp.) and tiger beetles (*Pseudotetracha whelani*) living on it. Based on experience of other lakes it was clear that other species existed there and since then a further six species have been collected (including beetles, ants, cricket and scorpion).

A total of twelve invertebrate species were collected from three saline habitats. Two species of beetle in the genus *Pogonus* were recorded from Lake Torrens for the first time. One appears to be within the *Pogonus* '*grossi* group', a difficult group and currently the subject of a molecular study using DNA. The other, a single specimen of *Pogonus perovalis* is particularly interesting as it is a flightless species which is also recorded from Lake Gairdner, Lake Hart and Island Lagoon. DNA analysis of several populations of this species found substantial sequence divergence. The *Pogonus* material from Lake Torrens will certainly be a very useful inclusion in the study of this group.

Three specimens of the ant *Iridomyrmex brennani* were collected from near Mountford Spring Island. This species was described in 2011 from specimens collected on or near salt lakes at Kambalda, Lake Acraman and the Murray Sunset National Park.

General invertebrates

Not all general invertebrate specimens collected have been sorted. Thirty-eight species of Coleoptera (16 families, 38 genera), 11 recognisable species of ant (3 genera), 16 recognisable species of Lepidoptera (16 genera) and five species of Odonata (3 families, 4 genera) were recorded. All species identified have widespread distributions.

Bees

Map searches using the PaDIL Australian Pollinators website showed that 27 species had been recorded in the area prior to the Bush Blitz. During the Bush Blitz, specimens of 364 native bees were collected from 17 flowering plant species—87 species were found, including representatives of all five Australian bee families. Only eight of the species recorded previously were collected during the Bush Blitz, so the total recorded native bee species for the area increased to 106. A number of these species are

confirmed to be undescribed, but it is expected that several others will be undescribed as well, after further identifications and careful comparison with museum specimens.

The native bee biodiversity on the pastoral properties was found to be much higher than assessed in the field. Because most species were only encountered in low numbers and collected during a short period, the findings are just a snap-shot of the potential bee biodiversity on the properties. A species accumulation curve of additional bee species collected over successive days during the survey hardly shows a decreased rate of species discovery towards the end of the survey, indicating the potential discovery of many additional species. The overall native bee diversity can be expected to be higher if surveyed over longer periods and during different seasons.

Wasps

This Bush Blitz added a valuable contribution to baseline knowledge of the fauna of the Lake Torrens National Park and adjoining stations as there is currently little information on the parasitoid Hymenoptera of the region. A total of 143 morphospecies were identified to genus where possible, the majority of specimens to family/subfamily. Further determination of species' identity is still in progress. The highest recorded diversity was for the superfamily Chalcidoidea, with 77 morphospecies, followed by the families Ichneumonidae and Braconidae with 34 and 30, respectively. Three described species of Gasteruptiidae are new records for the reserves, extending their ranges. A very small, representative sample of other parasitoid Hymenoptera were collected during the survey, with a single species of Dryinidae (multiple-winged males), two morphospecies of Pompilidae and Mutillidae and a single large morphospecies of Sphecidae.

Only a very small number of Evanioidea were taken across the survey area. This was unexpected as suitable hosts (wood-boring beetles, native cockroaches and native solitary bees) were readily collected. Only the family Gasteruptiidae was represented. This was surprising as, previously, the standard sampling techniques used successfully collected members of the other families. Only male gasterotruptiids were collected during the survey, possibly attributable to the timing of the survey. Although the biology and flight times of Gasteruptiidae is highly variable and understudied in Australia, it is speculated that males may emerge before females and set up territories around food resources and host nest sites. A delay in adult female emergence could be the reason for collection of males only. A higher diversity of gasteruptiid species may exist in the survey region, but have been missed during the Bush Blitz. The results should be considered a representative snapshot of the total Evanioidea biodiversity of the study area.

Sweep-netting and active searching is effective for larger Hymenoptera but has limitations, with very small parasitoids often overlooked or not encountered. Mass collection techniques like use of Malaise traps were most effective for collecting parasitoid Hymenoptera. For future surveys, employment of multiple collection techniques is recommended as there was significant variation in the species collected with each technique.

Further identification work on the remaining parasitoid material is expected to reveal a higher diversity among the larger groups, Ichneumonoidea and Chalcidoidea. These super families were best represented in the survey and are groups most likely to have species with high ecological and economic roles in the control of insects. The study area has an excellent mix of habitat/vegetation types and the preliminary data indicate that the region is quite promising for further research into Hymenoptera diversity. Continued conservation of areas of high quality habitat is recommended.

Stygofauna

No stygofauna was found during the Bush Blitz. However, groundwater-dependent fauna was found in the outflow of a spring near Wilaroo Lagoon on Andamooka Station. The fauna consisted of chiltoniid amphipods, harpacticoid copepods and *Turbellaria*. The species found are most certainly undescribed.

The mound spring found near Wilaroo Lagoon, close to the former 'flowing bore' is a unique feature, with unique aquatic species in the outflow of the spring that are restricted to this very small area. The fauna would be highly vulnerable to disturbances such as desiccation or pollution. When visiting the spring, a number of dead cows were found in the surroundings and also in the actual spring vent, making the water putrid. None of the taxa found in the outflow were found in the vent, where they normally would occur, and where source populations of fauna exist under fluctuating water levels. It is possible that under the current situation, with no fauna in the spring vent, fauna may go extinct if the outflow area dries out when water flow decreases. To conserve these unique fauna the following recommendations are made—fence off the mound spring and its outflow area and clear out the vent, but ensure that the outflow area does not dry out or become contaminated during the process.

Jumping plantlice

Australian Psylloidea now number 402 described species, but many more new species are represented in collections and remain to be collected. Few species are recorded from South Australia, as much of the taxonomic work has been concentrated in eastern Australia. A total of 22 species of Psylloidea were newly recorded from Andamooka Station and the Lake Torrens region. Among these are four described species in three genera, referred to two families, and 18 putative new species in six genera in three families. The Psylloidea are highly host specific and host association data were recorded for most species. Host plants include various species of *Acacia*, *Amyema*, *Dodonaea*, *Eremophila*, *Eucalyptus* and *Myoporum*. The distributional data represents new species and host records for the region, with significant infill distribution records for the four described species. New species of *Acizzia* will be described from the material collected during this survey and will contribute to a current ABRS-funded project 'Systematics, biodiversity and host associations of Australian psyllids: Implications for conservation and biosecurity' to be undertaken by Dr Gary Taylor at the University of Adelaide.

Spiders

Despite challenging conditions, with huge downfalls of rain making some roads inaccessible for several days, the Bush Blitz was very successful for spider collecting. In general, it was difficult to identify specimens beyond genus level. Five new species across four different genera were discovered. It is likely that many more taxa also represent new lineages. Unfortunately, without mature males and/or molecular data, there is not enough data to be sure.

Without further survey work it is difficult to know how rare any of these species might be, and thus difficult to say which species should be a priority. The trapdoor spider genus *Blakistonia*, which appeared to have an affinity with the gibber plains habitat in Standard Survey Site 2, did appear to be in concerningly low numbers. Pitfall trapping in the wet season, as well as searching for and documenting juvenile burrows, would give a better indication of whether these specimens are indeed part of a healthy, breeding population, and collection of mature males would help us to make an informed decision as to whether they are conspecific with surrounding species of *Blakistonia.*

Isopods

An unexpected large number of oniscidean isopod specimens (over 220) were collected from the study area, including Andamooka, Roxby Downs, Purple Downs and Pernatty station. No previous information was available on occurrence of crustacean fauna, including oniscidean isopods, in the study area.

The morphological studies, based at the University of Adelaide, showed the occurrence of at least nine species belonging to the families Armadillidae (six species; genus *Buddelundia*, and an unknown genus), Philosciidae (at least two species; *Laevophiloscia*) and Porcellionidae (at least one species; genus *Porcellionides*). Morphological analyses suggest that at least four species, including three species of *Buddelundia* (Armadillidae) and one species of *Laevophiloscia* (Philosciidae), collected from Lake Torrens and Andamooka may represent new species. The unknown status of the putative new species isolated inside Lake Torrens (Mountford Spring Island) and its small population size, raise important conservation issues and indicate a need for future planning by land managers. Molecular studies and additional discovery field trips are needed to assess the diversity of the oniscidean isopods and their gene flow across Lake Torrens.

Snails

Three of the four species of molluscs collected on the survey were identified as species that are relatively common and widespread in this general area of South Australia.

Sinumelon hamiltoni appears to be characteristic of arid range systems to the east of the Flinders Ranges. Most of the 29 records now in the SA Museum are of collections of dead shells. Soft tissues have been collected from only three locations. The sub-fossil specimens collected on this survey from Shell Lagoon are 85 km ESE from the nearest living record but still within the Arcoona Land System. It may be that further searching in the gorges above the Shell Lagoon location may reveal another living population.

Sinumelon remissum is one of the common and widespread *Sinumelon* species in the Flinders Ranges and surrounding plains. There are 97 records in the SA Museum but only three records of living animals. In addition there are three records from the eastern and southern shores of Lake Torrens. The record from Bosworth Station on the Bush Blitz confirms its association with the larger sandy creeklines throughout this general area.

Isidorella newcombi was found in three freshwater habitats—cane grass swamps, creek line waterholes and artificial dams. Living material was obtained from Andamooka Waterhole. The SA Museum collections of aquatic snails have yet to be properly identified, registered and databased.

As expected, very few habitats in the study area were suitable for either land or aquatic snails. When it can be examined by a specialist on hydrobiid snails it will be interesting to discover the identity of the unknown aquatic snail.

Flora

The Bush Blitz was undertaken following a season of above average rainfall when ephemeral plants were abundant and well represented. Specimens of 996 plants were collected—849 vascular plants, 41 bryophytes, 20 algae (incl. cyanobacteria), 1 undetermined taxon, 85 fungi and lichens. Leaf samples from almost all specimens were collected into silica gel for future DNA analysis. The collections have been databased and lodged at the State Herbarium of South Australia (AD), with a significant number of duplicates at the National Herbarium of Victoria (MEL).

From these specimens, 385 discrete plant taxa were recorded—358 vascular plants, 16 bryophytes, 4 algae, and 7 cyanobacteria. Ten lichen and 18 non-lichenised fungi species were also recorded. Incorporating ALA specimen records and some known non-databased AD records, gives a total of 699 vascular plants for the study area, of which only 88 are introduced weeds and a further five listed as questionably native.

One plant of particular focus during the Bush Blitz was *Sclerolaena* sp. Yeltacowie (A.Sinel & R.Kelman CAR037) P.J.Lang. This taxon was first discovered on 10 May 2014 during a pastoral inspection on Pernatty Station by Andrew Sinel who took specimens to AD for further investigation by botanist Peter Lang. It is known only from a single site which occurs within the study area near Yeltacowie outstation. This site was targeted during the Bush Blitz and the extent of the population was confirmed. The population is estimated to comprise about 500 plants scattered over an area of around 400 x 200 m. No other occurrences were found, despite searching in similar habitat nearby and elsewhere on the survey.

To sample the variation present, ten individuals were collected from across the extent of population, each supported by leaf tissue samples for DNA. Some variability was noted between individuals in fruit size and shape, indicating that plants have grown from sexually produced seed and therefore not likely to be a single clone.

Sclerolaena sp. Yeltacowie appears to be closely related to *Sclerolaena intricata* but is readily distinguished by the reduced number of spines and distinctively elongate floral tube. It may prove to be a distinct, but related species, or it may only be a hybrid between *S. intricata* and another species. One possibility for the other parent, based on morphological resemblance, is *Neobassia procera*. This would explain its divergence from *S. intricata* by contributing features of the more open spreading habit, the stronger ridging on the stems, the extremely elongate fruit tube, and the slightly more hairy axils and young leaves. An intergeneric hybrid would not be particularly surprising here, given that the generic delineations within a group of genera allied to *Sclerolaena* and *Maireana* appear somewhat artificial and arbitrary.

This postulated hybrid parentage is supported by the co-occurrence of *S. intricata* at the site. However, *N. procera* was not recorded there, although it does occur in the study area in similar habitat further north on the western side of Lake Torrens. The other S*clerolaena* species detected at the site, *S. ventricosa* (BS1097-406, & -412), seems an unlikely candidate for parent based on its morphology.

The highly restricted occurrence, lack of an obviously differentiated niche, and occurrence within an extensive but generally uniform area (Arcoona Plateau Land system) tends to favour the hybrid origin hypothesis, but does not preclude it from being a distinct species. To resolve this question, it is recommended that the status of *Sclerolaena* sp. Yeltacowie be investigated using molecular methods, with DNA sequencing of the putative parents and potentially related *Sclerolaena* species.

Fungi

A total of 26 collections of macrofungi were made over the two week period even though there had been considerable precipitation in the weeks leading up to the survey. The majority were common arid country species, 10 puffballs (*Podaxis pistillaris*, *Tulostoma* spp., and *Disciceda* spp.) and four Agaricales (*Montagnea arenaria*, *Agrocybe* sp., *Agaricus* sp. and *Galerina* sp.). The only rare finds were two rust fungi—*Uromycladium tepperianum* on *Acacia ligulata* and *Puccinia* sp. on *Enchylaena tomentosa*.

Eight substantial collections were made of galled *Maireana pyramidata* (2), *Sclerolaena diacantha* (4), *Atriplex vesicaria* (2), and a small collection of *Enchylaena tomentosa* (1), and *Tecticornia pergranulata* (1, no herbarium collection). Gall midges, parasitoid wasps and associated microfungi were sampled

from each population of galled plant material where possible. No new species were found among the galled chenopods. Plant material was duplicated (AD and MEL), galls and microfungi in ethanol (MEL), and gall midges and parasitoids for DNA barcoding and vouchers have been submitted to the South Australian Museum Terrestrial Invertebrate Collection. The only rare find was the first record, in five years of searching, of the fruiting structures of the microfungus *Botryosphaeria dothidea*, found in an *Asphondylia mcneilii* gall (associated with larval chambers) on *Sclerolaena diacantha*.

The Lake Torrens area provided a diverse range of habitats, ecotones and vegetation types. The plant survey was successful as it occurred during a peak flowering/seed period due to good rains. The highly seasonal nature of macrofungi fruiting makes it hard to pick peak sampling times, however, spring is not it—autumn-winter would be a better time to survey for this group. It was fortunate that three chenopod plant hosts were heavily infested with galls. These, however, were all common and widely distributed taxa. In the hope of finding some of the rarer gall-midge/chenopod host interactions, it will be necessary to conduct more targeted sampling and to encourage anyone undertaking fieldwork in chenopod scrubland to be on the lookout for and to make collections of 'affected' material.

Glossary

Cryptic species (cryptospecies): species that are physically similar but genetically different and reproductively isolated from each other.

Cryptogam: an organism that reproduces by spores, without flowers or seeds. Includes bryophytes (hornworts, liverworts, mosses), lichens, fungi, slime moulds and algae. The term as used here does not pertain to ferns and fern allies as is sometimes part of the definition used by some authors.

Ecological communities: unique and naturally occurring groups of plants and animals. Their presence can be determined by factors such as soil type, position in the landscape, climate and water availability.

Herpetofauna: the reptiles and amphibians of a particular region, habitat, or geological period.

Hyporheic zone: the region below and alongside a streambed where groundwater and surface water mix in the gaps within the sediment.

Macrofungi: fungi that produce large fruiting bodies (i.e. those visible to the naked eye and generally one centimetre or more in width or height).

Morphospecies: a group of individuals considered to belong to the same species on the grounds of morphology (physical features) alone.

PaDIL: a website resource that provides high quality images and information tools designed for biosecurity and biodiversity. PaDIL is an initiative of the Australian Government's Department of Agriculture, in collaboration with Museum Victoria, Plant Health Australia, the Department of Agriculture and Food Western Australia and the Plant Biosecurity Cooperative Research Centre.

Putative new species: an unnamed species that, as far as can be ascertained, was collected for the first time during the Bush Blitz.

Range extension: increase in the known distribution or area of occurrence of a species.

Species range: the geographical area within which a particular species can be found.

Stygofauna: animals that live in underground water, including crustaceans, worms, snails, insects, other invertebrate groups, and in Australia a blind fish and a newt.

Taxon (plural taxa): a member of any particular taxonomic group (e.g. a species, genus, family).

Taxonomy: the categorisation and naming of species. The science of identifying and naming species, as well as grouping them based on their relatedness.

Type locality: the location where the primary type specimen(s) (holotype or syntype series) was found.

Type specimen(s) (holotype, syntypes): the specimen (or set of specimens) on which the description and name of a new species is based.

Undescribed taxon: A taxon (usually a species) that has not yet been formally described or named.

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BushBlitz
SPECIES DISCOVERY PROGRAM

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