

## SUPPLEMENTARY INFORMATION

The following sections outline the many ways the State of South Australia has been engaged with attempting to improve the prospects of its biodiversity over recent years.

### ***Focus on revegetation***

Overall, land clearing is by far the greatest threatening process to South Australia's terrestrial species (Bradshaw 2012; Evans 2016; Government of South Australia 2018), so it stands to reason that programs to revegetate previously cleared land with native plants have been emphasised throughout much of the State, and especially in its agricultural zones. Over several decades up until the present, many different revegetation programs have been initiated with the intent of bringing back some semblance of native forest and/or grassland function. Many of these have been small-scale ventures to assist in revegetating tracts of farmland, or others that have a broader-scale, regional focus such as the Coorong, Lower Lakes and Murray Mouth Community Revegetation Program (2010-2016) funded under the \$610 million *Murray Futures* project that has to date planted 1.4 million plants covering 90 thousand hectares (Government of South Australia 2018). Further, non-for-profit groups like Greening Australia ([greeningaustralia.org.au](http://greeningaustralia.org.au)) and Trees for Life ([treesforlife.org.au](http://treesforlife.org.au)) continue to assist land owners and community groups across the State to revegetate areas with native species. However, broader coverage, more regional coordination and connectivity, linking plantings to specific conservation outcomes, idealising the species combinations per habitat type, and linking to other ecosystem services (e.g., carbon sequestration, pollination efficiency) have so far not been examined or planned in much detail within most revegetation projects.

### ***Rewilding and fauna reintroduction***

(Re)introducing native fauna serves two main purposes: (i) to reduce the risk of species going extinct by increasing abundance, the number of populations, and/or genetic diversity (Frankham et al. 2014; Traill et al. 2010), and (ii) to reintroduce an ecological function once provided by (often another) species that is no longer present (e.g., top predators) (Seddon et al. 2014). Such actions can dovetail with other goals, such as reintroducing species following the control of invasive species and/or establishing a fenced protected area.

There have been several successful attempts to reintroduce or restock native wildlife in areas of South Australia where they are threatened with extinction. Some of the most successful include the reintroduction of yellow-footed rock wallaby (*Petrogale xanthopus*) to restored habitats in the Flinders Ranges (Zoos South Australia 2018), the reintroduction of warru (black-footed rock wallabies *Petrogale lateralis*) into the northern Anangu-Pitjantjatjara-Yankunytjatjara ('APY') lands (Natural Resources Alinytjara Wilurara 2018), and recent attempts to reintroduce western quolls (*Dasyurus geoffroii*) and brush-tailed possums (*Trichosurus vulpecula*) to the arid interior of South Australia (Natural Resources SA Arid Lands 2018) under the auspices of the *Bounceback* program — a landscape-scale conservation program to protect and restore semi-arid environments in the Flinders, Olary, and Gawler Ranges (Natural Resources SA Arid Lands 2018). There is also the potential for

a major rewilding project in Yorke Peninsula coordinated by a consortium of groups, provided invasive predator (i.e., foxes and cats) removal precedes any reintroduction (Natural Resources Northern and Yorke 2018). This latter program is perhaps one of the most daring attempted to date, and if it works, it could represent one of the greatest conservation gains South Australia has ever experienced.

### ***Invasive species control***

Feral cats and foxes are two of the most destructive invasive species in Australia in terms of their negative impacts on native wildlife (Doherty et al. 2017; Doherty et al. 2016; Woinarski et al. 2018; Woinarski et al. 2017), so it makes sense that their removal, or at least reducing their densities, will have many positive flow-on effects for South Australia's native wildlife (whether for remaining or reintroduced populations).

Some of the more publicised predator eradications include cat and fox reductions in fenced areas in the arid mid-North (e.g., the mostly industry-funded Arid Recovery — [aridrecovery.org.au](http://aridrecovery.org.au)), fox reductions to benefit yellow-footed rock wallabies in the Flinders Ranges (Centre for Invasive Species Solutions 2018), and malleefowl (*Leipoa ocellata*) in southern Yorke Peninsula (Natural Resources Northern and Yorke 2018), and council-level cat and fox trapping initiatives (with varied success) around the State.

Perhaps one of the most promising projects is the Kangaroo Island Feral Cat Eradication Program that is just getting underway (Natural Resources Kangaroo Island 2018). The fact that Kangaroo Island *is* an island (island species tend to be the most susceptible to cats) (Medina et al. 2011) that could be quarantined from further cat immigration from the mainland, that it still has no foxes, and that much of it remains forested, it is the ideal place to attempt such a challenging, yet potentially rewarding project.

Other promising moves forward is the recognition by many regional councils that house cats pose immense threats to local wildlife, even if they appear not to hunt native species (when, in fact, they do — Lepczyk et al. 2004; Loyd et al. 2013), and the ensuing restrictions on cat ownership, compulsory cat registration and microchipping, desexing, and confinement curfews (Adelaide Hills Council 2018; Dog and Cat Management Board 2018). The trend for more councils to adopt increasingly restrictive by-laws for cat ownership and management will likely reduce the pressure on native wildlife to some extent.

There are many other animal species that have been the target of eradication programs, including feral goats (PIRSA 2018), dromedary camels (Centre for Invasive Species Solutions 2018), various deer species (PIRSA 2018), and European rabbits *Oryctolagus cuniculus* (PIRSA 2018). Success has varied (i.e., some success with goats, less with camels, and deer), but arguably the most conservation and agricultural benefit has been the case of large reductions in wild rabbits following the release and spread of two rabbit-specific viruses: *myxoma virus* and *rabbit haemorrhagic disease virus*. In fact, South Australia is leading the country in terms of rabbit control using these diseases, with substantial gains in native vegetation cover (Burrell et al. 2017) and the recovery of small mammals following the release of grazing pressure and lower predator densities (Pedler et al. 2016) after large, disease-driven declines in rabbits since the 1950s (Barnett et al. 2018).

### ***Environmental flows***

Many of South Australia's rivers, creeks and even lakes are highly regulated by artificial dams and locks that attenuate the flooding and drying cycles in natural systems. Hence, ephemeral wetlands and floodplains tend not to experience the flooding necessary for long-term native plant (and animal) survival unless we specifically release water to them. These 'environmental flows' are increasingly used to mimic natural cycles (e.g., those that are nationally legislated, but not always done, under the Murray-Darling Basin Plan) (Murray-Darling Basin Authority 2018), and are being used in some Council regions successfully (e.g., the Torrens, South Para, and Onkaparinga Rivers environmental flows within the Adelaide and Mount Lofty Ranges Natural Resource Management region) (Natural Resources Adelaide and Mt Lofty Ranges 2018), although the full impact on native biodiversity is still largely unmeasured (despite some anecdotal reductions in the frequency and intensity of toxic algal blooms in the Torrens River since initiation of environmental flows) (Natural Resources Adelaide and Mt Lofty Ranges 2018).

### ***Wetland improvement***

Despite many threats to South Australia's few remaining wetlands (Brookes 2018), there have been several examples of successful restoration and even entirely new creation of wetlands in South Australia. The recently completed First Creek Wetland in the Adelaide Botanic Gardens not only purifies run-off, it provides habitat for birds, insects, and fish, and saves the Botanic Gardens large volumes of water for other irrigation requirements (Botanic Gardens of South Australia 2018). The Adelaide Hills Council also invested in returning the Laratinga Wetlands in Mount Barker to a fully functioning and biodiverse wetland in only a few years (Adelaide Hills 2018). Likewise, the Nature Foundation of South Australia's Water for Nature program (Nature Foundation South Australia 2018) has supported the restoration of many wetlands and environmental flows, and Nature Glenelg Trust has restored several local wetlands (Nature Glenelg Trust 2018).

### ***Sanctuaries***

Approximately 30% of the State's land area is protected in part for its biodiversity values, albeit most of this is the semi-arid and arid regions of the State where there is relatively lower species richness and endemism compared to the wetter regions to the south (Government of South Australia 2018; Guerin et al. 2016).

Overlaying the State of South Australia's Protected Areas boundary data ('Conservation Reserve Boundaries'; data.sa.gov.au) with the Interim Biogeographic Regionalisation for Australia (IBRA Version 7; environment.gov.au) layer indicates that 73.2% of the total protected area (excluding Indigenous Protected Areas) in South Australia lies in the arid biogeographic regions of Great Victoria Desert (21.1%), Channel Country (15.2%), Simpson Strzelecki Dunefields (14.0%), Nullarbor (9.8%), Stony Plains (6.6%), Gawler (6.0%), and Hampton (0.5%) (Fig. 2, main text). Comparing the distribution of the Conservation Reserves with maps of South Australia's species richness and endemism from Guerin et al. (2016) demonstrates clearly that most of the protected-area network within the state therefore covers regions of lowest richness and endemism (Fig. S1, reproduced from Guerin et al. 2016).

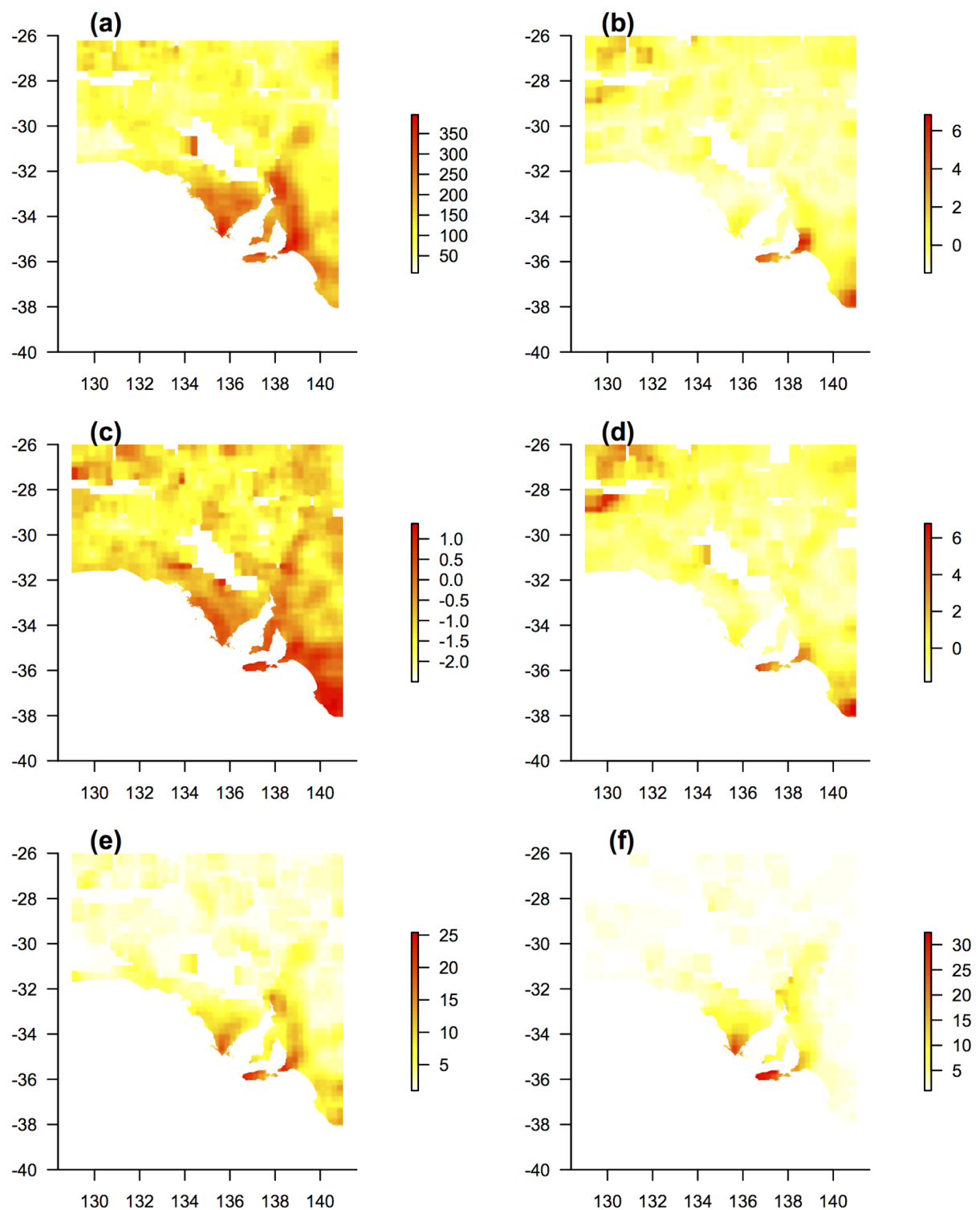


Fig. S1. “Maps of measured biodiversity metrics. Maps are smoothed at a resolution of 1 km<sup>2</sup> with values given per surrounding 0.25° × 0.25° area: (a) Estimated species richness based on non-parametric estimator (plot data); (b) georeferenced weighted endemism of native species (plot data)—continuous outlier metric; (c) phylogenetic diversity (plot data)—continuous outlier metric; (d) georeferenced phylogenetic endemism (plot data)—continuous outlier; (e) species richness of conservation-dependent species (plots); (f) species richness of categorical

South Australian endemics (plot data).” Reproduced under a Creative Commons Attribution License from Figure 2 in Guerin et al. (2016).

Fortunately, the number of protected areas and their total area coverage is increasing throughout most of the State, although there is probably inadequate coverage of unique ecosystems in some regions such as Northern and Yorke (8%), South Australian portion of the Murray-Darling Basin (18%), and the South East (24%). Some areas in the arid north under the designation of Indigenous Protected Areas (Ross et al. 2009) are large (e.g., the 1.2 million ha Watarru Indigenous Protected Area in the north east of the State) (Australian Government Department of the Environment 2018), but most in the southern, more biodiverse areas are small (e.g., the 2680 ha Wirrabara Range Conservation Park, and the 177 ha Little Mount Crawford Native Forest Reserve). Other types of reserves are becoming increasingly popular, such as the previously mentioned Arid Recovery ([aridrecovery.org.au](http://aridrecovery.org.au)) fenced reserve funded mainly by the mining industry, for-profit, and educational wildlife parks (e.g., Cleland Wildlife Park, Warrawong Wildlife Sanctuary), and urban parks (e.g., Adelaide Botanic Gardens, Oaklands Wetlands, Urrbrae Wetland, Greenfields Wetlands).

### ***Climate-change strategies***

The recent warming of the Earth’s climate due to human society’s production of greenhouse gases, and the inevitable continuation of this trend, are unequivocal (Cook et al. 2013; Intergovernmental Panel on Climate Change 2014; IPCC 2013; Suppiah et al. 2006). South Australia has wisely recognised that our changing climate threatens not only our biodiversity (Brereton et al. 1995; Guerin et al. 2018; Hughes 2003; Strona, Bradshaw 2018; Urban 2015; Warren et al. 2018; Williams et al. 2009), but also the high quality of life most South Australians enjoy via increasing risk of drought, flood, bushfire, heatwave death, and reduced agricultural production (Hennessy et al. 2005; Hughes 2003; Williams et al. 2009). To that end, the State Government (Government of South Australia 2018), all regional councils, Natural Resource Management boards, and municipalities have relevant climate-change strategies and legislation. While it is arguable that these do not go far enough given the magnitude of ongoing change (Intergovernmental Panel on Climate Change 2018), the attempts to mitigate and adapt are essential.

### ***Engaging people***

Society does not have much hope of limiting the erosion of our biodiversity if people do not value, are not engaged with, or are otherwise indifferent to nature and its plight (Clayton, Myers 2015; Miller 2005; Milton 2002). To improve the engagement with people — from farmers, to developers, to average citizens — many programs have been rolled out to promote awareness and appreciation of natural values in South Australia. One of these is the not-for-profit Nature Play SA ([natureplaysa.org.au](http://natureplaysa.org.au)), which aims to get more children playing outside in their own backyards, parks, and wild places. Similarly, places like Morialta Conservation Park has developed programs for children to engage with native flora and fauna (Natural Resources Adelaide and Mt Lofty Ranges 2018). Establishing reserves and parks near or in South Australia’s principal urban area (Adelaide), such as Tennyson Dunes

Conservation Park, Adelaide International Bird Sanctuary National Park, and Cromer Conservation Park ([parks.sa.gov.au](http://parks.sa.gov.au)), provide extensive opportunities as multiple-use areas to engage mainly urban visitors. Other endeavours to encourage people to get back to nature include opening some conservation reserves to camping (e.g., Onkaparinga River National Park), although such policies remain controversial, because some environmental purists argue that protected areas should be off-limits to recreationists to reduce their potentially negative impacts on protected flora and fauna.

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