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Estimating the benefit of well-managed protected areas for threatened species conservation

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Title:

Estimating the benefit of well-managed protected areas for threatened species conservation

Abstract

Protected areas (PAs) are central to global efforts to prevent species extinctions, with many countries investing heavily in their establishment. Yet, the designation of PAs alone can only abate certain threats to biodiversity. Targeted management within PAs is often required to achieve fully effective conservation within their boundary. It remains unclear what combination of PA designation and management is needed to remove the suite of processes that imperil species. Here, using Australia as a case study, we use a dataset on the pressures facing threatened species to determine the role of PAs and management in conserving imperilled species. We found that PAs that are not resourced for threat management could remove one or more threats to 1185 (76%) species and all threats very few (n=51, 3%) species. In contrast, a PA network that is adequately resourced to manage threatening processes within their boundary would remove one or more threats to almost all species (n=1551; ~100%) and all threats to almost half (n=740, 48%). However, 815 (52%) species face one or more threats that require coordinated conservation actions that PAs alone could not remove. This research shows that investing in the continued expansion of Australia's PA network without providing adequate funding for threat management within and beyond the existing PA network will benefit very few threatened species. These findings highlight that as the international community expands the global PA network in accordance with the 2020 Strategic Plan for Biodiversity, a much greater emphasis on the effectiveness of threat management is needed.

Keywords:

Threats; threat management; protected area management; protected area effectiveness, Aichi Targets, EPBC Act; Australia.

Introduction

Nationally designated protected area (PA) networks are now central to biodiversity conservation strategies globally (Coetzee et al. 2014; Watson et al. 2016) as they are considered the most effective way to overcome the threats that are causing the current biodiversity crisis (Rands et al. 2010). While recent research has found that PAs generally support greater species richness and abundance than comparable areas that are not protected (Barnes et al. 2016; Gray et al. 2016), and they are mostly effective at mitigating vegetation clearing by human activity (Naughton-Treves et al. 2005; Joppa et al. 2008), there is also evidence that under current levels of funding, many PAs are unable to abate the many other processes that cause species decline (Craigie et al. 2010; Joppa & Pfaff 2011). Despite pronounced PA expansion over recent decades and ambitious global targets for future growth under the 2020 Strategic Plan for Biodiversity (CBD 2011; UNEP-WCMC & IUCN 2016), surprisingly little is known about the extent to which they can abate the full range of threatening processes that imperil species (Watson et al. 2014).

Given the central—and sometimes sole—focus on the establishment of PAs to fulfil international conservation targets (Joppa & Pfaff 2011; Lopoukhine & de Souza Dias 2012; Dudley et al. 2014), it is important to understand the extent to which PAs can mitigate threatening processes. For example, Australia's National Reserve System is the country's most important investment in biodiversity conservation (Commonwealth of Australia 2013b) and in 2014, the Environment Minister announced to the World's Park Congress that Australia had achieved its international commitments because it reached the areal component of the goal of 17% of land within PAs as outlined in Aichi Target 11 of the Strategic Plan for Biodiversity (Secretariat of the CBD 2010; Hunt 2014). Many other nations are making progress towards their own PA coverage targets. For example, both South Africa and Canada are planning a significant increase to their PA networks to make their contribution to the global 17% target by 2020 (Government of South Africa 2010; Government of Canada 2016).

As national and global PA networks are dramatically expanded to halt biodiversity decline (Venter et al. 2014; Watson et al. 2014; Barr et al. 2016), it is vital to understand their effectiveness at conserving biodiversity. Given Australia is one of the first nations to have claimed to have met the 17% terrestrial area target, it is a useful case study in which to assess the extent that PAs can abate those processes that threaten species. Despite having a large PA network, the country has a poor history of recent extinctions (Woinarski et al. 2016), and with over 1700 species currently listed as threatened with extinction nationally (Commonwealth of Australia 2015), further extinctions are likely (Woinarski et al. 2015). Furthermore, most Australian species face multiple threats

(Evans et al. 2011) that require a variety of actions to mitigate. These range from PA designation and targeted threat management across protected and non-protected areas, to stronger legislation and better land-management practices (Lindenmayer 2015, Woinarski et al. 2015, Woinarski et al. 2016).

Quantifying the variety of actions needed to mitigate the impacts of threats on imperilled species is vital in understanding the response required to conserve threatened species. Where legal support for PAs are strong, their designation alone will be effective at mitigating a number of threats, particularly those that cause habitat loss (e.g. agriculture, urbanization). Nevertheless, many threats operate irrespective of land tenure and as such, management is required to mitigate their impacts. Where threats can be dealt with at a local or point-basis, targeted management within a PA will effectively mitigate these (e.g. invasive species; fire); whereas some threats are pervasive across the landscape and therefore require a systematic management approach both inside and outside of PAs (e.g. invasive diseases and pathogens). In Australia for example, threats such as inappropriate fire regimes and invasive species are contributing to the severe decline of numerous mammal species in one of Australia's premiere protected areas (and a UNESCO Natural World Heritage site), Kakadu National Park (Woinarski et al. 2011). To adequately conserve these threatened species, PA managers must be resourced to undertake intensive management of these threats. In evaluating the role of PAs in threatened species conservation, it is vital to recognize that in many circumstances PA designation must be complemented with management to effectively conserve species.

Here we provide the first holistic assessment of the extent to which a continental PA network mitigates the range of threats to species at risk of extinction. In doing this we aim to understand how effective PAs are at removing the processes that threaten species with extinction. Using a recently compiled national database on the threats to Australian species, we summarize the range of management actions required to mitigate these threats. Using this summary we quantify the role that PAs play in separating threatened species from the processes that threaten their persistence.

Methods

Australian threatened species data

Species that have been classified as threatened by the Australian Department of the Environment and Energy's Threatened Species Scientific Committee and Minister are listed under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999 (Commonwealth of Australia 2017b). We undertook this study in early 2017, at which time there were 1749 Australian species listed as threatened under the EPBC Act. We followed previous studies (Carwardine et al. 2008; Evans et al. 2011) and included all terrestrial and freshwater vertebrate, invertebrate and plant species, as well as marine species that rely on land or freshwater for a part of their life-cycle. We only considered threats to marine species that originate and require management on land. Excluded from the analysis were extinct species, species that face uncertain threats and exclusively marine species. In total, 1555 Australian threatened species were considered in this analysis.

Threatening process data

Information on Australian threatened species and the threats reported as impacting them are available through the Species Profiles and Threats (SPRAT) Database (Commonwealth of Australia 2015). The SPRAT database provides threat data on species protected under the EPBC Act and has been used in a number of studies that assess threatening processes on Australian species (Evans et al. 2011; Walsh et al. 2013). For this study we used information from the SPRAT database that was current as of late 2015.

The information on threats is compiled using a range of sources including listing advice, recovery and action plans, published literature and expert knowledge (Commonwealth of Australia 2015). It is likely that this information is not exhaustive and the listed threats are likely to be those that are obvious and tangible to endangered species' managers, meaning subtle threats may be overlooked and not reported. The SPRAT database follows the standardised Threats Classification Scheme outlined by Salafsky et al. (2008). These threat classifications are the same as those used by the International Union for Conservation of Nature (IUCN) for the Red List of Species process and allows comparison across regions and taxonomic groups (IUCN 2016). This threat classification scheme contains 11 direct threats types and one type for new and emerging threats ('Other options'; Salafsky et al. 2008). The classification scheme is based on a three-level hierarchy, with each level increasing in detail and specificity. The first level (major threat) being the broadest, the second level (sub-threat) being more defined and the third level (specific threat) being at a much finer scale. Each major threat has between three and six sub-threat classifications. Table 1 provides a full description and specific details for each major threat classification.

Threat management

We used government threat abatement plans and peer-reviewed literature to identify potential management actions to mitigate each threat. While there is potentially a number of ways to remove each threat and local context influences what is the most appropriate action, we identify what would generally be the conservation action or combination of actions used to mitigate each threat. For clarity we followed the standardised lexicon provided by Salafsky et al. (2008) for conservation actions. Table 1 contains a summary of the threat and conservation action required and Supplementary Table S1 contains the reasoning for the choice of each action.

Assessing the effectiveness of the PA network to manage threats

There is no dataset available that provides information on how each individual PA mitigates the threats occurring within it. We therefore classified each threat relative to how effective the PA network could be in overcoming it. We followed the standardised conservation actions as defined by Salafsky et al. (2008). Conservation actions are interventions that need to be undertaken to reduce the extinction risk of a species (Salafsky et al. 2008). Using these conservation actions, we defined three distinct threat management scenarios for PAs.

The first, which we label 'unmanaged', considers PAs as a legally designated land-use, which can overcome threats causing vegetation clearance and habitat loss but where on-ground threat management such as invasive species control and fire management does not occur (Table 1). This scenario captures a situation where PA managers are inadequately resourced to undertake on-ground threat management, as is likely to be the case in some PAs across Australia (Taylor et al., 2011a; Craigie et al. 2015). It should be noted that in some countries, PAs are ineffective at achieving their primary goal due to poor legislative support (Watson et al. 2014). PAs designated but never implemented – commonly referred to as 'paper parks' – are unlikely to be able to abate the threats we discuss here.

The second scenario, which we label 'well-managed', considers a PA as not only a legally designated land use, and hence able to stop habitat loss, but one where there is adequate funding and resources provided to undertake effective management of threats within its boundary. Here, management is a broad term that refers to on-ground activities that mitigate the processes that threaten species within the PA boundary. Management actions range from invasive species control and fire management, to enforcement and habitat restoration (Table 1 provides full details).

Additionally, a number of threats to Australian species are unable to be adequately mitigated by PAs, no matter how well resourced and managed (Gaston et al. 2008). Instead these threats require a coordinated response across protected and non-protected areas, which we label as 'landscape management' (Table 1). An example of threats that require a landscape management approach are the invasive diseases and pathogens listed as key threatening processes under the EPBC Act (Commonwealth of Australia 2017a). These diseases impact 161 Australian threatened species and are thought to have caused or contributed to at least four extinctions of

Australian species (Commonwealth of Australia 2005, 2006, 2014). The threat abatement plans for these diseases emphasise a number of management actions to be coordinated nationally. These are minimising the spread of the disease by controlling dispersal through quarantine actions and controlling the movement of infected species, mitigating the impact on species at infected sites through identified means, and the establishment of a captive breeding program for species at high risk of extinction (Commonwealth of Australia 2005, 2006, 2014). While effectively managed PAs play a vital role in mitigating the impact of threats such as this, a coordinated threat management approach across the broader landscape is needed to ensure effective conservation.

It must be noted that there are local factors that require interpretation to determine the most appropriate management action. These factors influence both the impact of threats and the effectiveness of the management action required to deal with it. For example, the impact of salinity can vary widely in its scale and severity. Where its impact is localised, a PA with restoration efforts can effectively mitigate this. Whereas when salinity impacts an entire landscape, as is occurring in Australia's Murray-Darling Basin, a landscape management approach is required (Murray-Darling Basin Authority 2015). Similarly, to adequately mitigate the impact of a number of invasive species, multiple levels of management may be required. For example, to abate the immediate impact of an invasive plant species, on-ground control (e.g. spraying, physical removal) is first needed (IPAC 2016) but then should be complemented with local (and potentially national) policies aimed at minimising its spread and establishment in new areas (IPAC 2016). Additionally, the size of a PA has a significant impact on its effectiveness at mitigating threats. For example, the conservation of large, intact landscapes are the best response to the impacts of climate change (Watson et al. 2009; Gross et al. 2015). As such, small PAs which comprise a high proportion of Australia's PA network (Commonwealth of Australia 2013a), are unlikely to be able to mitigate the impacts of such threats. Here, we determined the typical actions used to mitigate each threat. Supplementary Table S1 provides a full reasoning for the choice of the conservation action required to mitigate each threat to Australian species.

Level of threat abatement

To estimate the role of PAs in threatened species conservation in Australia, we quantify the level of threat abatement provided by each management scenario. We do this by calculating the proportion of threats removed by each scenario to Australian threatened species, and the number of species which have one or more and all threats abated by each management scenario. While these calculations are theoretical, by comparing the effectiveness of the two PA management scenarios we approximate the role that well-managed and unmanaged PAs play in threatened species conservation in Australia.

Results

The threats impacting Australian species

Australian threatened species face 11 major threat classes, with invasive and other problematic species impacting the greatest proportion of species (n = 1274, 82%; Fig. 1). Two other major threats, natural system modifications and agriculture, impact over half of Australia's threatened species (n = 1136, 73% and n = 874, 56%, respectively; Fig. 1). The sub-threats of invasive non-native species (within the major threat class invasive and other problematic species; 80%) and fire and fire suppression (within the major threat class natural system modifications; 65%) threaten the greatest number of Australian threatened species.

The number of threats reported as impacting Australian species

Each Australian threatened species is impacted by between 1 and 10 major threats (Fig. 2a) and 1 and 54 specific threats (Fig. 2b). On average, each species faces 7.6 specific threats (± 5.8 SD). Only 95 species (6%) face a single specific threat, while 1025 species (66%) face 5 or more specific threats (Fig. 2b).

The number of threats mitigated by each management scenario

Under our unmanaged PA management scenario, where PAs are not resourced for on-ground threat management, the Australian PA network can remove 26% of all threats to Australian threatened species (Table 2). We found that while the PA network could mitigate one or more threats to 1185 (76%) species, it could only remove all threats to 51 (3%) species (Table 2). In contrast, the well-managed scenario, where PAs are adequately resourced for on-ground threat management, Australia's PA network can remove 86% of threats to all threatened species. Similar to the unmanaged scenario, we found that although the well-managed scenario can remove one or more threats to almost all threatened species (n = 1551; ~100%), it can only remove all threats to 740 (48%) Australian threatened species (Table 2). Of great concern is that 815 species face threats that require coordinated landscape-scale management to adequately mitigate (Table 2). PAs alone, no matter how well managed, cannot remove all threats to these species.

The disparity between scenarios can be explained by the variety of threats to Australia species and the number of threats each species faces. Unmanaged PAs can only effectively mitigate threats causing habitat loss, particularly Agriculture, Urbanization and Transport corridors (Table 1). As the vast majority of Australian species face multiple threats, of which many require on-ground management to abate, unmanaged PAs cannot remove the majority of threats to Australian species. In contrast, well-managed PAs can abate the two greatest threats to Australian species – Invasive and other problematic species and Natural system modifications as well as threats causing habitat loss (Table 1). Hence, well-resourced PAs can remove all threats to many more species then unmanaged PAs. Although this accounts for the conservation of around half of Australia's threatened species, the other half require well-managed PAs complemented with threat management in non-protected lands. Threats from invasive diseases and pathogens, air and waterborne agricultural pollutants and altered flow regimes from dams require a combination of management across the entire landscape. As such, for all threats to be removed to all species and ensure the effective conservation of species in Australia, well-resourced PAs must be complemented with effective landscape-scale threat management.

Discussion

Using the actions required to mitigate threats to species, we evaluated the potential effectiveness of PAs, the predominant action taken to protect biodiversity globally, at conserving threatened species. Using Australia as a case study, we found that even in the best-case scenario where PAs are well-resourced and effectively managed, only 48% of threatened species will have all threats removed by the nation's PA network. These results based on the well-managed PA scenario are likely to be an over-estimate of the effectiveness of the current PA network, as the few studies that have discussed the adequacy of funding for management of PAs in Australia have shown that there are significant shortfalls across much of continent (Taylor et al., 2011a; Craigie et al., 2015). Taylor et al (2011a), for example made the case for an estimated seven-fold increase in investment needed to fill the current management and protection gap in Australia's PA network. Where PAs are inadequately funded to undertake on-ground threat management, very few species (n=51, 3%) will have all threats removed.

Similarly, this analysis overestimates the benefit to threatened species conservation provided by Australia's current PA network. With the majority of Australian threatened species inadequately represented in PAs and 10% of species having no coverage (Watson et al. 2011), PAs provide little to no benefit to these species. This highlights the importance of a landscape scale approach to threat management as many threatened species occur outside PAs, and half (n= 815, 52%) of Australia's threatened species face threats requiring concerted efforts across protected and non-protected areas. This emphasizes the need to not only fund establishment of new PAs but also to adequately fund the management within and outside of the current PA network.

These findings have significant implications for biodiversity conservation globally. As the international community undertakes concerted efforts to halt biodiversity decline (Juffe-Bignoli et al. 2014), too narrow of a focus on PA network expansion will likely lead to an insufficient response. The threat of invasive species, pollution and fire impact thousands of species globally (Maxwell et al. 2016; Rodrigues et al. 2014) and in many countries, invasive species impact a significant proportion of species (e.g. the United States; Wilcove et al. 1998). Therefore, we expect our findings to be similar in many other nations. While PAs play a crucial role in solving the biodiversity crisis, we have shown here that this investment will only bear fruit if it is complemented by effective threatened species management.

The PA management scenarios defined in this analysis are the two extremes of a spectrum. In Australia, few PAs are likely receiving no threat management actions within their boundary, just as few are likely to be adequately and effectively managed for all threats within their boundaries. Where Australia's current PA network is on this management spectrum is difficult to determine; however, based on reported funding for PA management, it is likely to be highly variable across Australia (Taylor et al. 2011a). Taylor et al. (2011a) report that in 2008/09, the average funding for PA management across Australia was $9.56/ha. While New South Wales has reported that impacts to threatened species in PAs is stable or improving for the majority, it is believed that in 6.6% of PAs, impacts are increasing (N.S.W. Government 2007). Considering the national average for PA management funding is less than one third of New South Wales (Taylor et al., 2011a), it is likely that many of Australia's PAs are inadequately resourced for effectively managing for all threats within their boundaries.

Our analysis emphasizes the importance of all threats being removed from threatened species. While it is unlikely that every threat must be removed to prevent species' extinction, recent Australian extinctions highlight that a more holistic approach to threat management in Australia is needed. Insufficient management of just a few threats resulted in these preventable extinctions (Woinarski et al. 2016). Well-funded, strategically planned and coordinated threat management across protected and non-protected areas in Australia is needed to conserve its unique biodiversity. Currently, available funding for threatened species protection and recovery in Australia is inadequate (Taylor et al. 2011a, Waldron et al. 2013). Additionally, the allocation of the limited available resources is currently biased (Walsh et al. 2013) and often ineffectively spent (Bottrill et al. 2011; Taylor et al. 2011b). While it is unlikely the suggested seven-fold increase in funding (Taylor et al. 2011a) for Australia's PA network will occur soon, efficiency can be addressed with a strategic planning process for threatened species management (Watson et al. 2010). Systematic and strategic investment of available funding through management action-specific planning protocols has proven effective and efficient (Bottrill et al. 2008; Joseph et al. 2009). These protocols incorporate cost, benefit and likelihood of success to ensure effective and efficient threatened species outcomes. While such protocols have been used in some states across Australia (Tasmanian Government 2010; N.S.W. Government 2013), a national approach is required given threatened species and the threats they face are unaffected by state borders. As such, a national approach is key to successful threatened species conservation in Australia.

As the global PA network continues to dramatically expand in an attempt to halt biodiversity decline, it is vital to understand its effectiveness at achieving this goal. Using Australia as a case study, we were able to provide the first continental evaluation on how effective a network of PAs is at removing the suite of threats that imperil species. We discovered that a PA network well-resourced for on-ground threat management within its boundaries could abate all known threats to half of Australia's threatened species. While PAs will play a role in reducing threats to the other half of Australia's threatened species, they are unable to mitigate all of the processes that impact these species. A coordinated approach across protected and non-protected areas is therefore required to adequately conserve these species.

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Author Contributions

Conception and design of study: S.K., V.A., R.F., H.P., J.W.; analysis and interpretation of data: S.K.; drafting the manuscript: S.K., J.W.; revising the manuscript: S.K., V.A., R.F., H.P., J.W.

Supplementary Material

A table with the threat classifications faced by Australian threatened species, the typical conservation actions taken to mitigate these and reasoning for the choice of this action, is available in Supplementary Table S1.

Biographical sketches

Stephen Kearney is interested in understanding the pressures to threatened species and how to efficiently mitigate these.

Vanessa Adams is focussed on the human dimensions of conservation and systematic environmental decision-making.

Richard Fuller is interested in understanding how people have affected the natural world around them, and how some of their destructive effects can best be reversed.

Hugh Possingham is interested in decision-making for conservation, including spatial planning, optimal monitoring, value of information, population management, prioritization of conservation actions, structured decision-making, bird ecology and dynamic systems control.

James Watson is a conservation biogeographer interested in identifying conservation solutions in a time of rapid anthropogenic change.

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Figure captions

Figure 1: The number of Australian threatened species facing each of Salafsky et al.'s (2008) major threat classifications (1a) and the relative impact of each major threat classification on Australian threatened species (1b). The relative impact is defined as the cumulative number specific threats within a major threat that impacts a species. It takes into account that species may face more than one specific threat under each major threat. For example, a species may be threatened by an invasive plant species and an invasive animal species and as such is impacted twice by the major threat classification invasive and problematic species. Threat information is compiled using a range of sources including listing advice, recovery and action plans, published literature and expert knowledge (Commonwealth of Australia 2015). It is likely that this information is not exhaustive and the listed threats are likely to be those that are obvious and tangible to species' managers, meaning subtle threats may be overlooked and not reported.

Figure 2: The number of Australian threatened species that face one or more major threat classifications (2a) and the number of threatened species facing one or more specific threats (2b). Species facing more than 30 specific threats (n=9, 0.006%) were excluded from graph 2b to enable better graphic presentation. Threat information is compiled using a range of sources including listing advice, recovery and action plans, published literature and expert knowledge (Commonwealth of Australia 2015). It is likely that this information is not exhaustive and the listed threats are likely to be those that are obvious and tangible to species' managers, meaning subtle threats may be overlooked and not reported.

Figures

Fig. 1

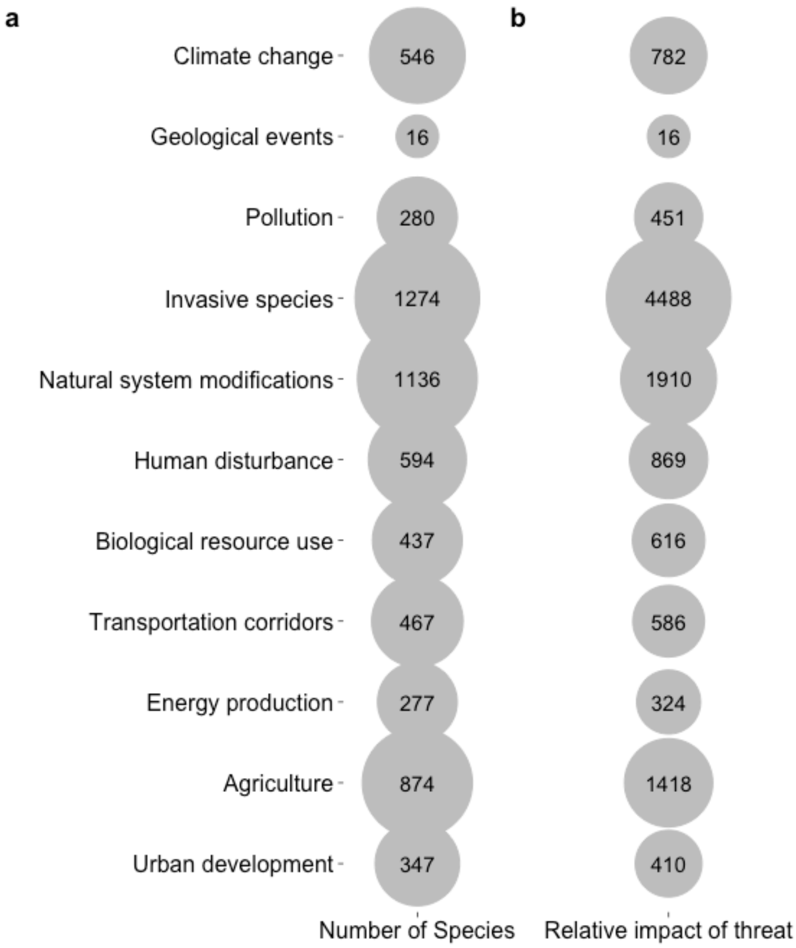
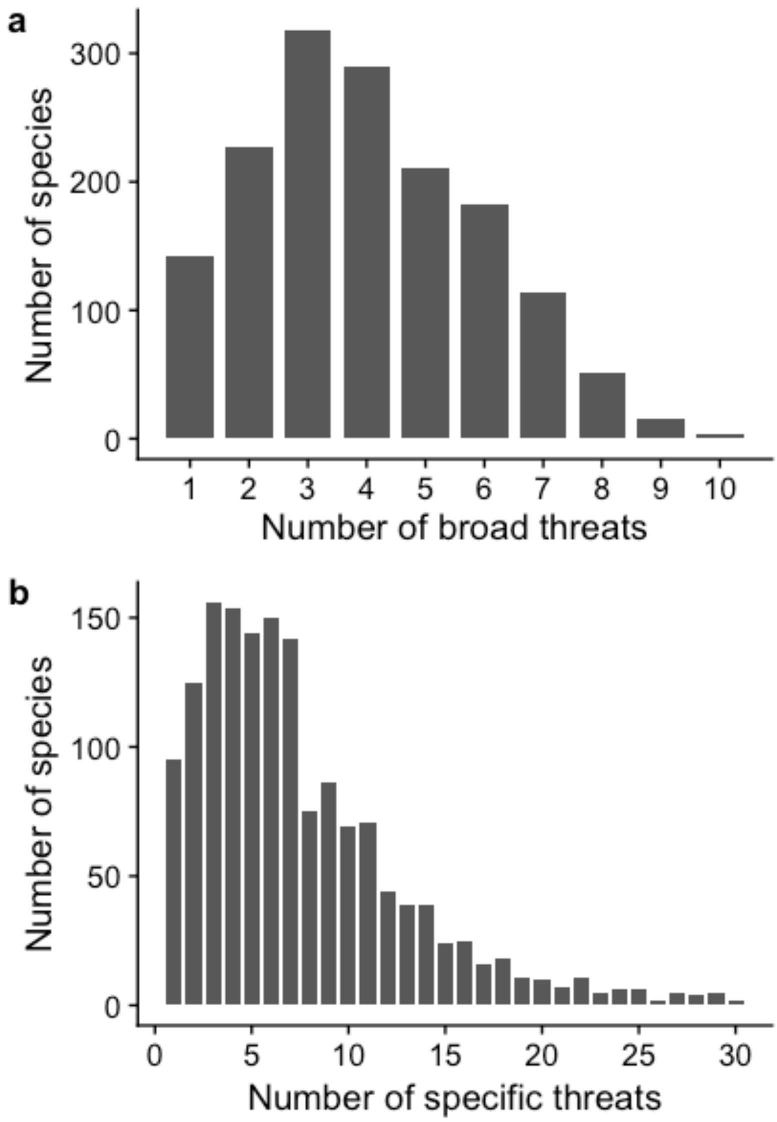


Fig. 2


a
Number of species
300
200
100
0
1
2
3
4
5
6
7
8
9
10
Number of broad threats
b
Number of species
150
100
50
0
0
5
10
15
20
25
30
Number of specific threats

Tables

Table 1: A description of the threat classifications, the typical conservation actions taken to mitigate these and our assessment of corresponding protected area management scenario. Threat classification, description and conservation actions taken from Salafsky et al. (2008).

Table 1

Major threat classification	Description	Sub-threats	Key conservation actions	Threat management scenario
Residential and commercial development	Threats from human settlements or other non-agricultural land uses with a substantial footprint	Commercial and industrial areas, housing and urban areas, Residential and commercial development, tourism and recreation areas	Site/area protection	Unmanaged
Agriculture and aquaculture	Threats from farming and ranching as a result of agricultural expansion and intensification, including silviculture, mariculture and aquaculture (includes the impacts of any fencing around farmed areas)	Agriculture, aquaculture, livestock farming/grazing, timber plantations	Site/area protection	Unmanaged
Energy production and mining	Threats from production of non-biological resources	Oil and gas drilling, mining, quarrying and renewable energy	Site/area protection	Unmanaged
Transportation and service corridors	Threats from long narrow transport corridors and the vehicles that use them including associated wildlife mortality	Roads and railroads, shipping lanes, transportation and service corridors, utility and service lines	Site/area protection	Unmanaged
Biological resource use	Threats from consumptive use of "wild" biological resources including both deliberate and unintentional harvesting effects; also persecution or control of specific species	Fishing/ harvesting/ collecting/ gathering terrestrial, marine and aquatic species	Site/area protection & Site/area management & Compliance and enforcement	Well-managed
		Commercial logging	Site/area protection	Unmanaged
Human intrusion and disturbance	Threats from human activities that alter, destroy and disturb habitats and	Human intrusion and disturbance, recreational	Site/area protection &	Well-managed

	species associated with non-consumptive uses of biological resources	activities, work and other activities, military exercises	Site/area management	
Natural system modifications	Threats from actions that convert or degrade habitat in service of “managing” natural or semi-natural systems, often to improve human welfare	Dams and water management	Policies & Regulations	Landscape management
		Fire and fire suppression, other ecosystem modification	Site/area protection & Site/area management	Well-managed
Invasive and other problematic species, genes and diseases	Threats from non-native and native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance	Invasive non-native species, problematic native species	Site/area protection & Invasive/ problematic species control	Well-managed
		Invasive diseases, pathogens and parasites	Invasive/ problematic species control	Landscape management
Pollution	Threats from introduction of exotic and/or excess materials or energy from point and nonpoint sources	Garbage and solid waste	Site/area management & Compliance and enforcement	Well-managed
		Agricultural and forestry pollutants, excess energy, urban sewage and waste water; industry/ military pollution	Legislation & Policies and regulations	Landscape management
Geological events	Threats from catastrophic geological events	Landslides	Habitat & natural process restoration	Well-managed
Climate change and severe weather	Threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or potentially can wipe out a vulnerable species or habitat	Climate change, severe weather, droughts, storms and flooding, temperature extremes, habitat shifting/alteration	Habitat & natural process restoration & Species re-introduction	Well-managed

Table 2: The total number (and percentage of total) of threats to all Australian species, the number of species with one or more threats, and all threats removed by the two protected areas (PA) management scenarios. The unmanaged scenario represents a network of protected areas that receives no funding for on-ground threat management, whereas the well-managed scenario represents a protected area network that is well-funded and all necessary on-ground threat management occurs. Landscape-scale management is required to mitigate threats that either originate outside of protected areas or require coordinated management across all land-tenures.

Table 2

	'Unmanaged' PA scenario	'Well-managed' PA scenario	Landscape management	All management types combined
The total number of threats removed to all Australian threatened species	3056 (26%)	10 220 (86%)	1651 (14%)	11 871 (100%)
The number of Australian threatened species with one or more threats removed	1185 (76%)	1551 (~100%)	815 (52%)	1555 (100%)
The number of Australian threatened species with all threats removed	51 (3%)	740 (48%)	4 (<1%)	1555 (100%)