Threatened Species Recovery Hub

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Protecting Australian mammals from introduced cats and foxes:

The current status and future growth of predator-free havens

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Protecting Australian mammals from introduced cats and foxes: The current status and future growth of predator-free havens
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Front cover image: Boodies (*Bettongia lesueur*) used to have a large distribution across two-thirds of Australia, but now only exist within seven havens, with more havens planned for them in the near future. However, while havens have been crucial for avoiding extinction and consolidating protection for boodies, arguably, new havens should now prioritise species with less existing protection.
Photo: Hugh McGregor, Arid Recovery.

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Greater Stick-nest rat at entrance to nest. Photo: Australian Wildlife Conservancy.

Introduction

Defining the predator problem

Many Australian mammal species are highly susceptible to predation by introduced cats (*Felis catus*) and European red foxes (*Vulpes vulpes*). At least 34 Australian endemic mammal species have been made extinct since 1788, about 10% of Australia's terrestrial mammal. Predation by introduced cats and foxes was a major contributor to most of those extinctions. The Australian mammal extinctions make up about one-third of all global mammal extinctions over the last ca. 500 years. Cats and foxes have also driven large distributional and population declines for many more surviving species.

Cats now occur across the entire Australian mainland and Tasmania, and are present on many of the larger islands. Foxes occupy most of the mainland south of the tropics; they are absent from Tasmania but present on some other large islands off the southern half of the continent. Many native species that do persist are doing so tenuously, often reliant on ongoing intensive conservation management. Some mammal species have avoided extinction only because they happened to have populations on islands that remained free of cats and foxes.

The responses to date

The past 30 years have seen a substantial increase in highly interventionist conservation efforts to prevent extinction and recover threatened mammal species by reducing predation pressure. These management responses include broad-scale poison-baiting; intensive trapping and shooting; and managing other factors – such as fire, dingoes, livestock, and other prey sources - that may influence the abundance, hunting proficiency, or diet of cats and foxes.

The management responses include conservation translocations to areas where threats are intensively managed. One approach to managing introduced predators is to translocate native mammals to predator-free islands and to fenced exclosures on the mainland capable of excluding cats and/or foxes, often jointly referred to as 'havens'. The term 'haven' has lacked a clear definition. It has been used to refer to any area where intensive management supports the persistence of an otherwise-declining population. It has also been used interchangeably with 'refuge' or 'refugia', terms that also refer to areas in which a principal threat is naturally absent or occurs at a level that does not affect population viability and persistence. We defined havens more specifically as islands and mainland fenced areas where the principal threat of introduced predators is either naturally absent or excluded by management.

The role of havens

Maintaining mammal populations on havens – whether they are naturally occurring or translocated – has helped to prevent further mammal extinctions, and consolidated protection for other species. These havens fall under the management of many organisations, ranging from local councils, community groups and small private organisations to large non-government organisations and state government environmental agencies. The current network of havens has thus grown organically rather than through nationally coordinated action. The distributed effort has resulted in diverse approaches and funding sources, but it also creates potential for inefficiency.

Wandiyali Restoration Trust conservation fence under construction in NSW just south of Canberra. Photo: C. Larcombe, Wandiyali Restoration Trust

Our aims

We set out to assess the current status of protection for mammal species that are susceptible to predation by cats and foxes, and to provide guidance to shape the future expansion of such protection.

What we did

The project had three stages:

1. Susceptibility to introduced predators

To identify the species most in need of protection from cats and foxes, we assessed the population-level susceptibility of each Australian terrestrial mammal species to predation by these introduced predators. Bats were excluded because they are not currently a primary focus for translocations and introduced predator management, although this does not imply that introduced predators have no impact on them.

We collated published information and complemented it with expert opinion to categorise the predator susceptibility of every Australian non-flying terrestrial mammal species as Extreme, High, Low, and Not susceptible. We then compared the predator susceptibility of species with IUCN conservation status, body size and extent of arboreality. Finally, we assessed changes in the distributions of species in the different predator-susceptible categories between 1788 and 2017.

2. Haven stocktake

We carried out a stocktake of the current network of island and fenced havens in Australia to assess the extent of the protection afforded by havens for self-sustaining populations of the threatened mammal taxa (species and subspecies) that had been identified in stage 1 as extremely or highly susceptible to predation by cats and foxes, as these species require the most interventionist and resource-intensive management, such as the creation of havens. We also widened the scope to include consideration of all extant subspecies.

We collated information from published sources, grey literature such as management plans and reports, and information obtained through personal knowledge and personal communications with conservation managers and scientists. We noted whether each population occurred naturally in their havens or had been translocated there. For translocated populations, we included them if they were translocated at least a year previously; translocations to havens generally have a high success rate, and where failures do occur, they tend to happen in the first year.

3. Strategic national network of havens

Stage 2 of the project showed that the representation of predator-susceptible taxa across havens was very uneven – with some taxa well-represented, while others were not represented at all. In stage 3, we used a systematic planning approach to design the expansion of the haven network so that taxa would be more evenly represented across havens, and thus the extinction risk across all predator-susceptible threatened mammal taxa would be minimised.

We aimed to identify the minimum number and locations of future havens required to protect all taxa that need representation within six havens, three havens or at least one haven. Creating havens is time-consuming and costly. Use of this approach would ensure that minimal to adequate protection be achieved as quickly as possible, and likely at a lower cost.

Our prioritisation method identified which of Australia's 419 IBRA subregions should be targeted for future havens based on the mammal taxa they contained historically. We prioritised new havens if they afforded protection to taxa that were unrepresented in any existing havens; as the number of protected populations increased for each taxa, it was given a lower benefit score for additional representation. We chose to identify the locations for new havens at subregional scale, as the finer-scale decision of where to build the fenced area, or whether to choose an island (for subregions that include islands), depends on a suite of environmental (including habitat suitability), economic, social and logistic issues that are site- and case-specific.

Our key findings

1. Susceptibility to introduced predators

Of the 246 Australian terrestrial non-flying mammal species (including extinct species), the predator-susceptibility scores were as follows:

- **37 species are (or were) Extreme:** will not maintain viable populations unless introduced predators are absent or virtually absent.
- **52 species are High:** likely to persist over at least the medium term (e.g., 20 years) with introduced predators, but with severe reduction in population size or viability, or likely to persist with introduced predators where the predator abundance has been much reduced.
- **112 species are Low:** likely to persist with introduced predators, but with some reduction in population size or viability.
- **42 species are Not susceptible:** population size and/or viability likely to be unaffected by introduced predators.

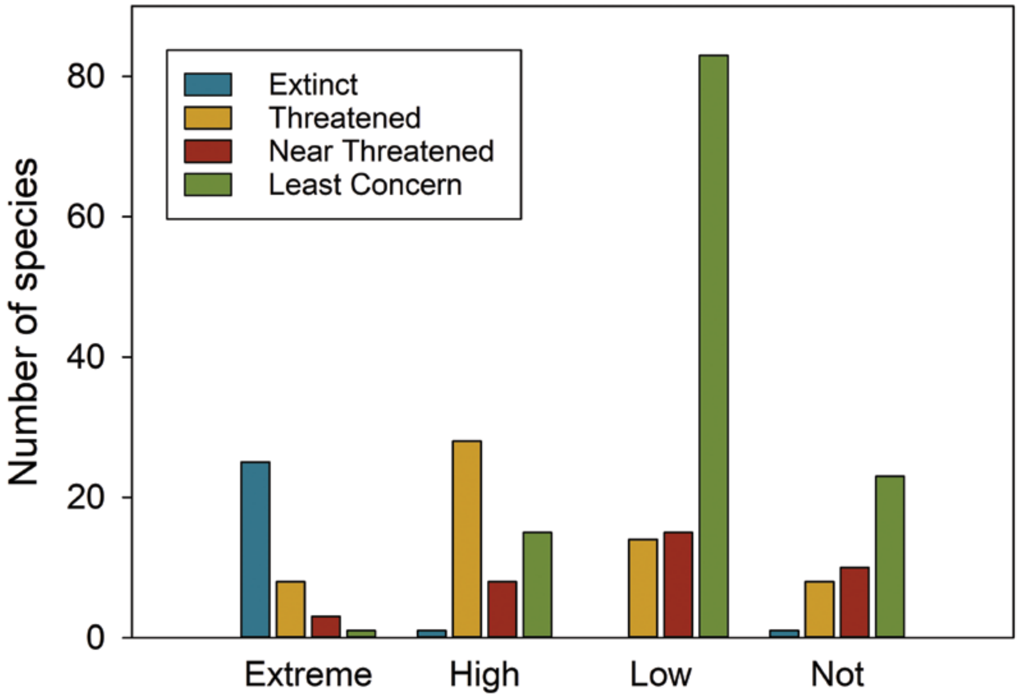


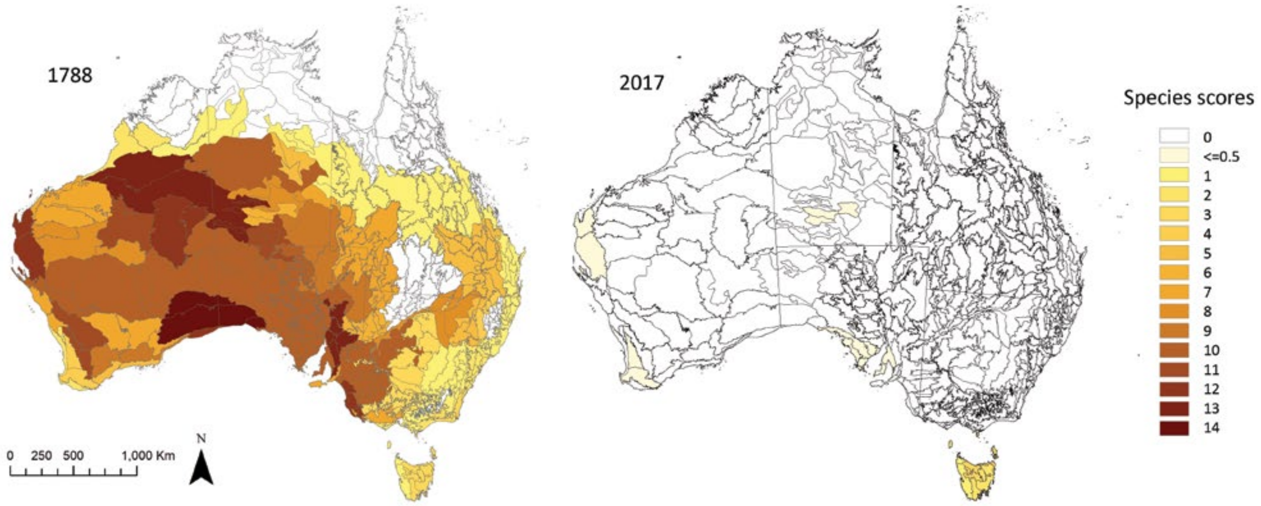
Figure 1: Predator-susceptibility of Australian native non-flying terrestrial mammal species in relation to conservation status.

Predator-susceptibility was significantly correlated with conservation status. Of the 37 species categorised as Extremely predator-susceptible, 25 are extinct and of the remaining 12, eight are threatened, three are Near Threatened and only one is Least Concern (Figure 1).

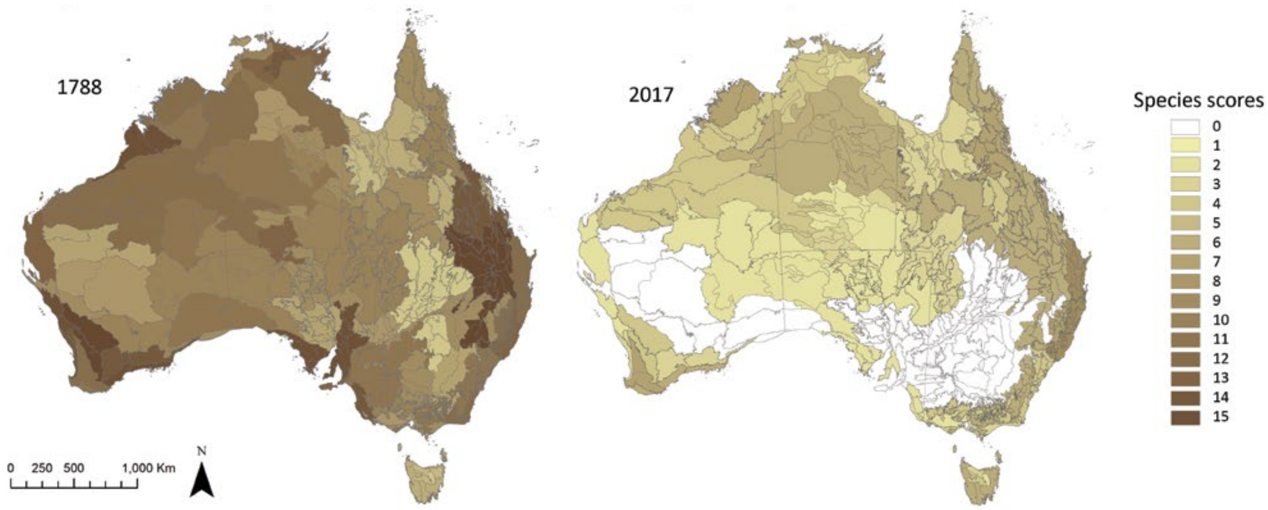
Arboreal species are less predator-susceptible than ground-dwelling species. Predator-susceptibility was also related to body size, with medium-sized species (35 g – 3.5 kg) more likely to be extremely or highly predator-susceptible than smaller or larger species, as they are within the preferred prey weight range of cats and foxes.

There has been a catastrophic collapse of extremely predator-susceptible species across their continental range, with the exception of the persistence of some (primarily fox-susceptible) species in Tasmania, and some species on offshore islands. Highly predator-susceptible species have also suffered broadscale range reduction, especially in the arid inland, parts of Western Australia and the sheep-wheat belt of south-eastern Australia (Figure 2).

a) Change in occurrence of mammals that are extremely susceptible to foxes and cats



b) Change in occurrence of mammals that are highly susceptible to foxes and cats



c) Change in occurrence of mammals that have low, or no, susceptibility to foxes and cats

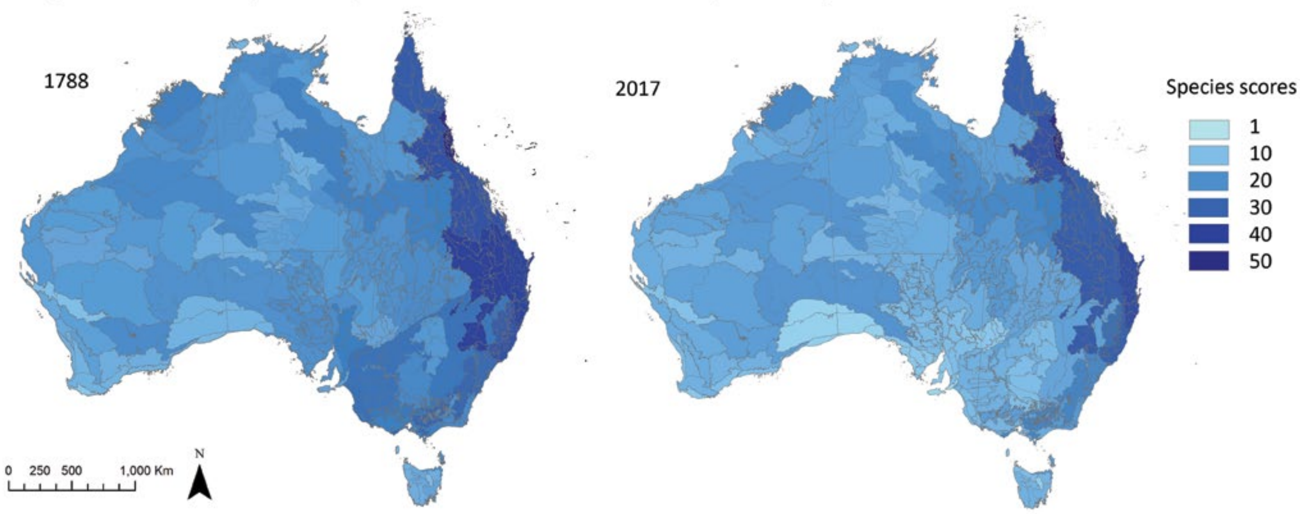


Figure 2. Change from 1788 to 2017 in the bioregional occurrence of species grouped by predator-susceptibility category. Scores are the number of species present in an IBRA region; if species are still present in a bioregion but their population is much reduced, they were given a score of 0.5. Note that changes on islands are not visible at this scale.

This assessment characterised the continental-scale response of a large group of species to the introduction of introduced predators, a single threatening process. Our findings support claims that Australia's native fauna are particularly susceptible to introduced predators relative to the native fauna of other continents; and that introduced predators can exert sustained continental-scale population-level impacts on native mammal prey species that result in catastrophic declines in abundance and range, local extirpation and global extinction.

The assessment is also valuable for shaping conservation management responses to protect different native species. For example, whereas species that are extremely susceptible to introduced predators are likely to require costly management interventions, native mammal species with lower predator susceptibility could benefit from less resource-intensive management of introduced predators implemented over larger areas.

2. Haven stocktake

The stocktake assessed the current levels of protection, within havens, for 67 predator-susceptible taxa (52 species). As of the end of 2017, 17 fenced areas with functional, predator-proof boundaries on the Australian mainland and 101 cat- and fox-free island havens were supporting 188 populations of 38 predator-susceptible threatened mammal taxa (32 species) (Figure 3). These numbers are increasing, because at least 14 new havens are currently being planned or constructed. In addition, there may be more island havens with naturally occurring populations of threatened mammals, as most Australian islands have never been surveyed. Most of the known island havens exist because they have never had foxes or cats and they also support populations of threatened mammal taxa, but 22 of the known island havens have been created by conservation managers through translocations, sometimes preceded by feral predator eradications ('created havens')

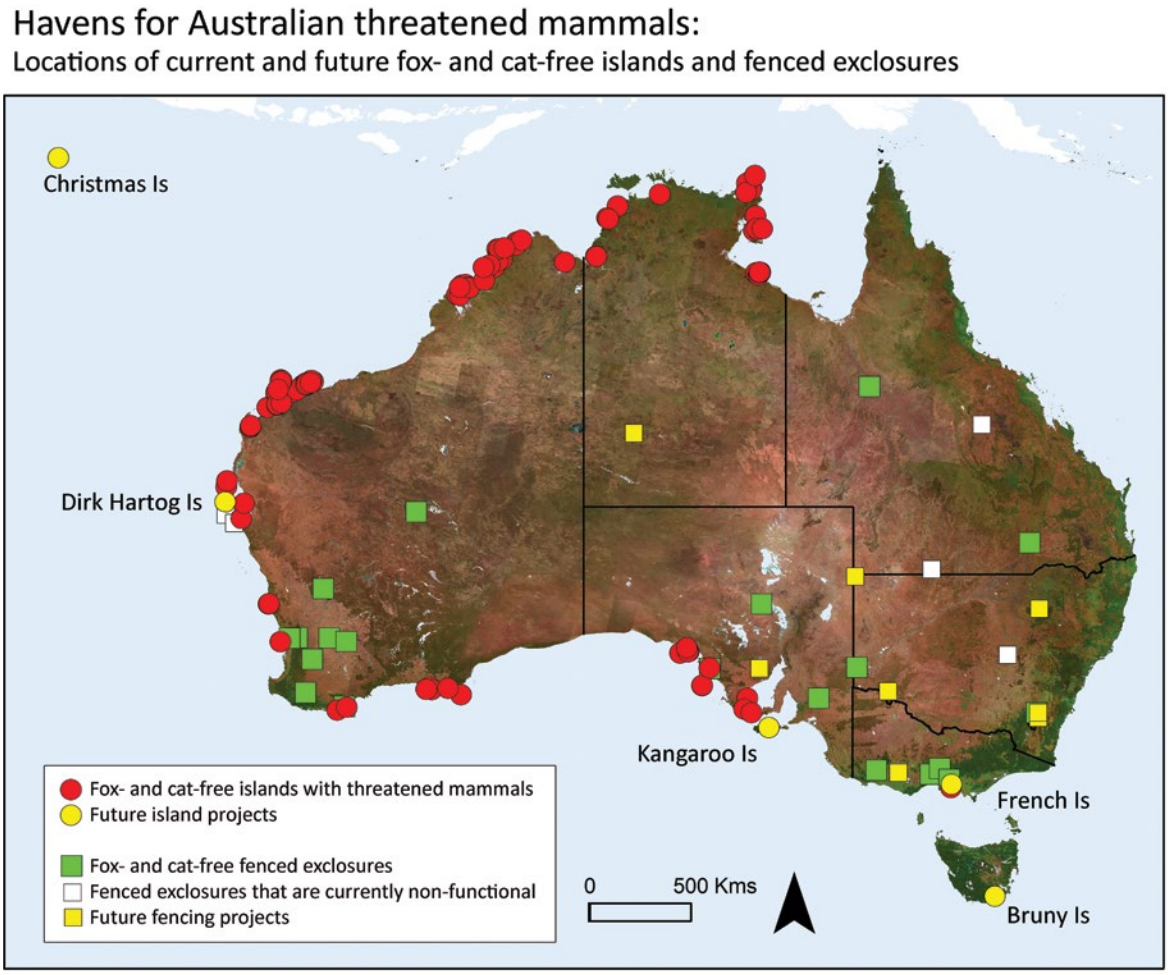


Figure 3: The locations of havens for threatened mammals that are susceptible to predation by cats and foxes. The map shows the locations of the 101 existing island havens, future island projects, and the locations of functional, non-functional and future fenced havens.

Table 1: Summary of the contributions of island and fenced havens to protecting extremely and highly predator-susceptible threatened Australian mammals.

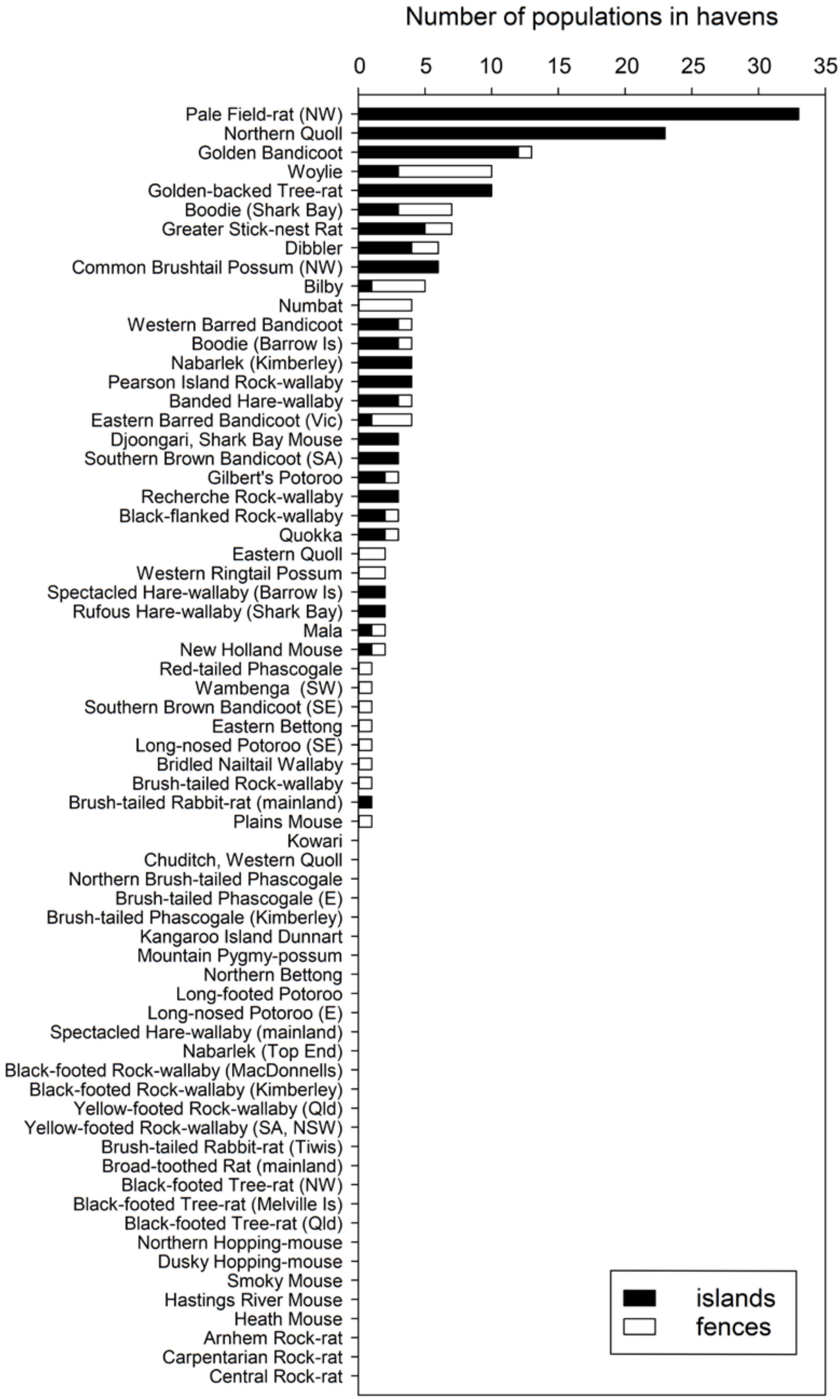
	Islands			Fenced areas			All havens
	Extremely susceptible	Highly susceptible	Total	Extremely susceptible	Highly susceptible	Total	
Number of populations	28	111	139	17	32	49	188
Naturally occurring populations	13	96	109	0	6	6	115
Translocated populations	15	15	30	17	26	43	73
Number of taxa	11	16	27	11	16	27	38
Number of species	9	13	22	9	16	25	32
Number of havens	16	90	101	11	15	17	118
Total haven area (km^2)	457	1992	2152	323	341	346	2498

Island havens cover a larger cumulative area than fenced havens (2152 km^2 versus 346 km^2) (Table 1), and reach larger sizes (the largest island is Barrow at 325 km^2, with another island of 628 km^2, Dirk Hartog, becoming available from 2018). By contrast, the largest area encircled by a fence is Arid Recovery, at 123 km^2. Despite the far greater area of island havens, they contain similar numbers of taxa to fenced havens (27 each), because fenced havens usually contain more taxa per haven. Populations within fenced exclosures are mostly translocated (43 of 49; 88%). Islands also contain translocated populations (30 of 139; 22%); but islands play a much larger role than exclosures in protecting in situ threatened mammal populations (109, versus six for fenced havens). The addition of Dirk Hartog Island in 2018 at 628 km^2 in area will cause the cumulative island haven area used in translocations to expand substantially.

Projects either underway or proposed aim to eradicate introduced predators from another five large islands totalling 5184 km^2 (French, 174 km^2; Bruny 356 km^2; Phillip, 101 km^2; Christmas, 137 km^2; and Kangaroo, 4416 km^2). In addition, several new fenced areas are underway or bring planned, that would cover a cumulative area of over 920 km^2.

Island translocations have been more successful than translocations to fenced areas, in terms of the proportion of translocated populations that have persisted for at least a year: 30/35 island populations (86%) versus 42/60 fenced populations (70%).

A key result of the haven assessment is that the representation of species within havens is very uneven. Some predator-susceptible taxa are well-represented in havens (16%, or nine taxa, are in six or more havens), but 29 taxa (43%) are not represented in any havens, and an additional 15 taxa (23%) occur in only one or two havens (Figure 4).



Australian mammals that are vulnerable to cats and foxes and how many havens they are in

Figure 4. Some predator-susceptible mammal species (and sub-species) are well-represented in existing havens, but a large percentage are poorly protected or not protected at all.

3. Strategic national network of havens

Australia's network of created havens (22 islands and 17 fenced exclosures) has not expanded in a manner that maximises representation of all predator-susceptible taxa (Figure 4). While each new haven project has made a substantial contribution towards securing individual taxa and achieving local conservation objectives, when they are viewed collectively, haven expansion is performing below its potential for securing all threatened predator-susceptible mammal taxa from extinction.

For example, the 11 most recently created havens have not added any new taxa to the network (although they have consolidated protection for some taxa) (Figure 5). If we carry on building new havens in way we have since the 1990s, we could double the number of havens from 39 to 78 but would expect to add only 10 of the 29 currently unrepresented taxa to the network (Figure 8).

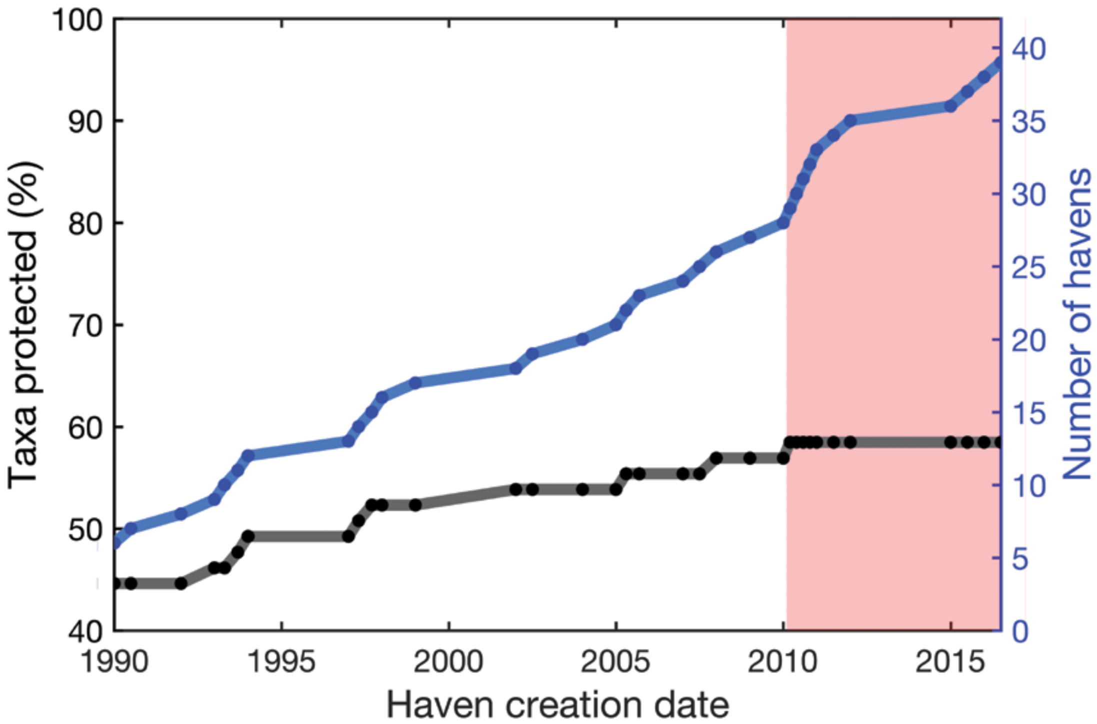


Figure 5. Increase in species representation as the haven network has expanded since 1990. The black line shows the change in the percentage of the 67 predator-susceptible taxa protected; the blue line shows the change in the number of havens over time. The pink band highlights that since 2010, 11 havens were created, increasing protection for taxa that were already present in existing havens, but without adding any new taxa to the network.

However, we could maximise national conservation objectives by choosing locations for new havens efficiently. Such an approach could minimise the number of new havens required to reduce extinction risk for the greatest number of predator-susceptible taxa, thus reducing cost overall. Reducing costs is important because havens are expensive to establish and maintain, and each new project requires years of planning, construction, eradication of introduced species and then translocations. Havens also need to be large enough to support genetically and demographically viable populations, and thus maximise the return on the original translocations, which often involve relatively small number of source animals.

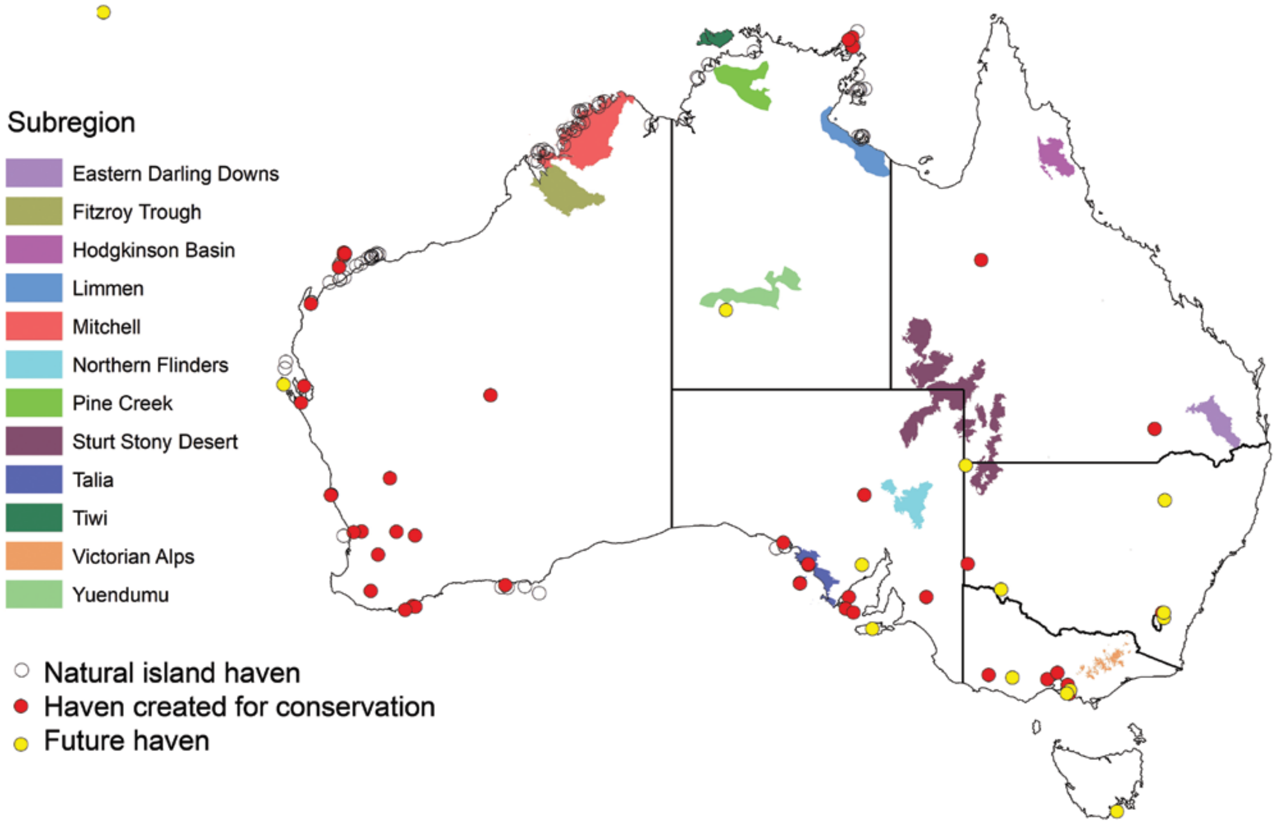
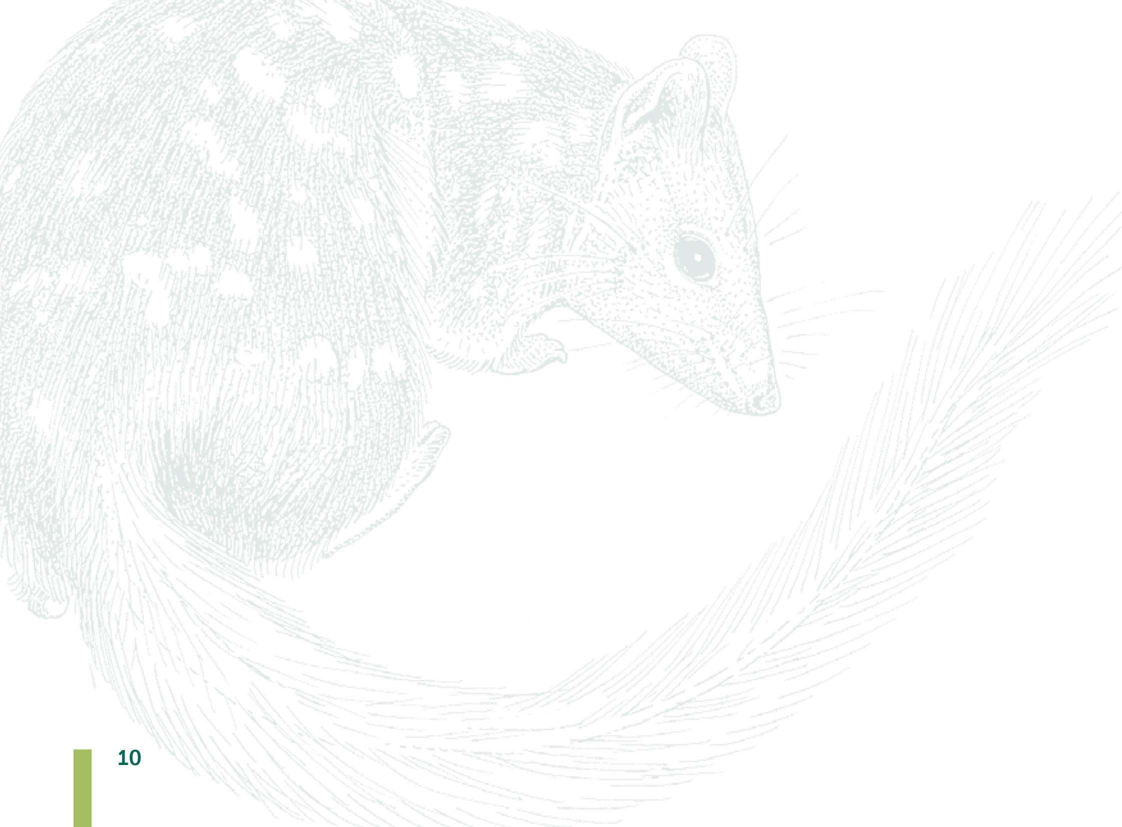


Figure 6: If new havens were created in each of the 12 subregions shown in the map, we could achieve representation, in at least one haven, for all 67 mammal taxa that are susceptible to predation by cats and foxes. The locations of existing havens are shown by red circles, and the locations of havens currently being established, by yellow circles.

Using a systematic planning approach, we found that we would need to create just 12 new havens to ensure that at least one population of all 67 predator-susceptible taxa was protected (Figure 6). At the current rate of haven expansion (16 new havens in the past 10 years), this crucial milestone is achievable within a decade. We also found that by doubling the number of new havens (from 39 to 78), we could protect at least three populations of all 67 target taxa (Figure 7). To ensure at least six populations of all 67 predator-susceptible taxa, which would provide a higher level of long-term protection of all species, we would need to build 94 new havens. At the current rate of haven expansion, this target would take more than 50 years. However, some predator-susceptible taxa still occur, although possibly with less security, in refugial wild populations outside of havens. If we include these populations in the target of having six populations per taxon, just 47 more havens are required, which could be achieved in considerably less time.



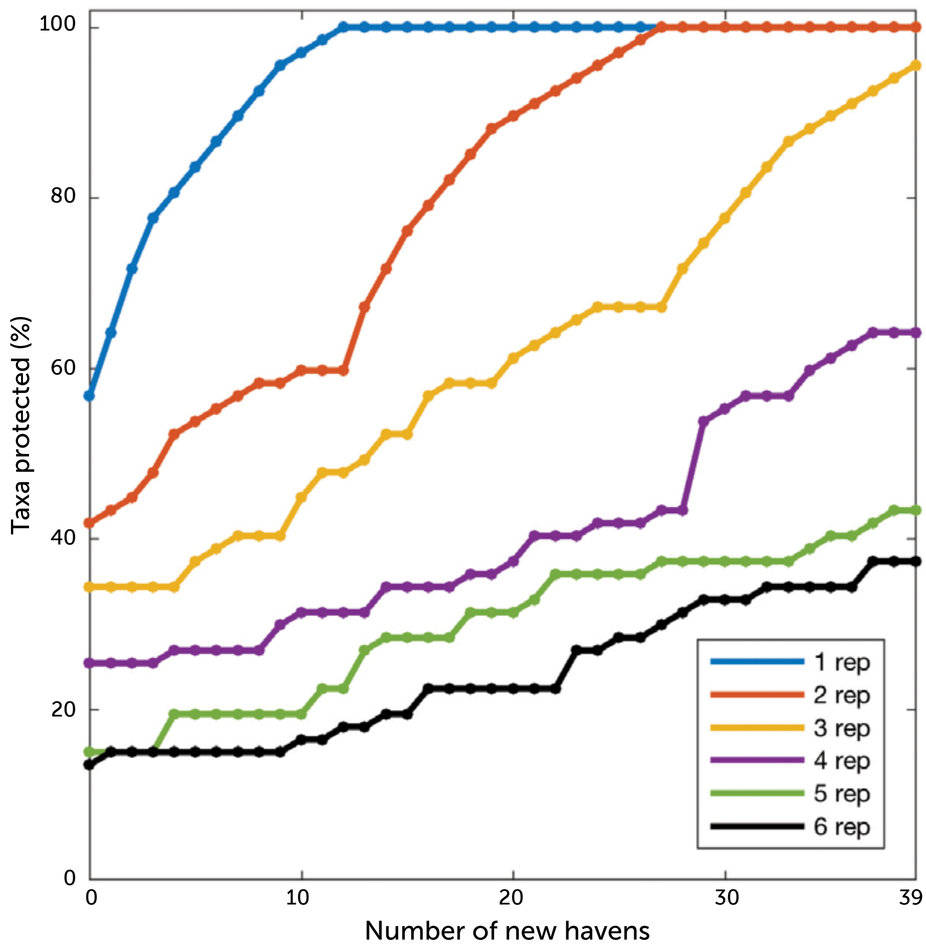


Figure 7: The proportion of predator-susceptible taxa represented in one to six havens, respectively, with the successive addition of new havens using systematic methods.

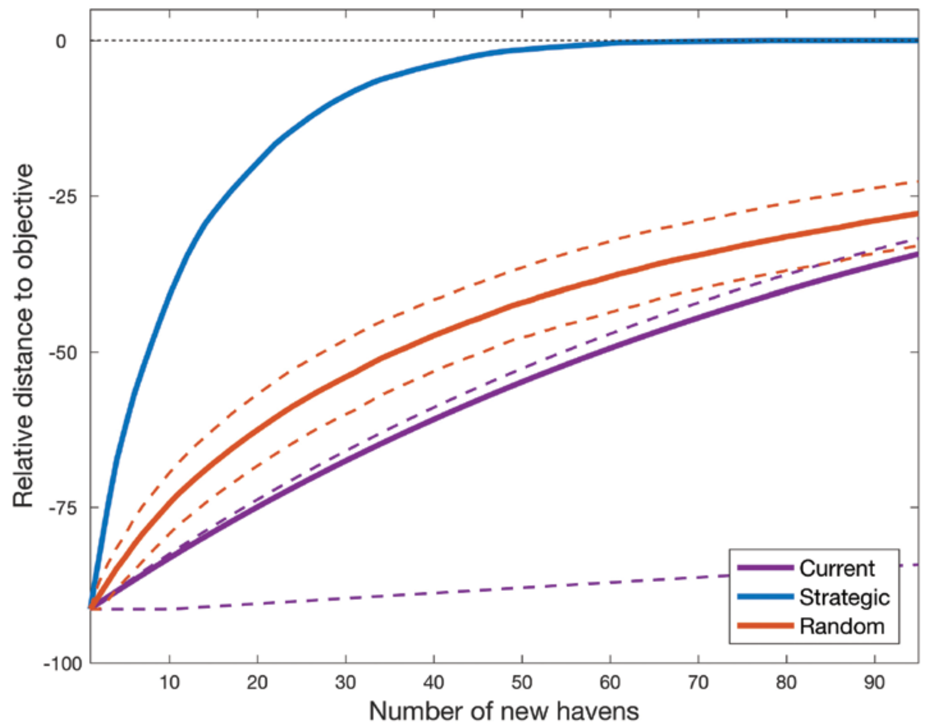


Figure 8: Accumulation curves demonstrating progress towards a target of having all taxa represented within at least six havens, as each new haven is added. Current or "business as usual" trajectory (purple line) is based on the extrapolating from the diminishing achievement of new havens to this target since 1990. Our best solution (blue line) uses systematic planning to choose location and constituent taxa in new havens based on the amount they contribute to closing our target gap. For comparison, the red line depicts the expected return on new haven projects selected by random. Dashed lines depict 95% confidence bounds for random and "business as usual" scenarios.

Implications

Created havens have increased the protection for many mammal taxa, but when viewed at a national scale, the expansion of the haven network has favoured some taxa at the expense of others. Future investment in havens should be prioritised in areas that can support taxa with no (or low) existing representation in havens, and on locations that can maintain diverse species assemblages. For example, government funding could be used to leverage contributions by the private sector in haven projects in priority areas.

Mechanisms to support and enhance collaborations among organisations that manage and create havens may help build a nationally coordinated approach to haven expansion. For example, financial support for multi-species recovery teams, and brokering of co-funded investments across jurisdictions and organisations, could go some way to achieving efficient placement of havens in areas that have been neglected to date.

Havens can be critical for avoiding extinctions in the short term, but they only cover a minute proportion of species' former ranges, which means the ecological role of these mammal species has been lost from vast areas. In addition, haven populations remain at a high risk of extinction from demographic population failure, catastrophic events and the continuing threat of introduced predators. Improved options for perpetual control of the impacts of cats and foxes at landscape scales must be developed and implemented to support the re-introduction of predator-susceptible species into open landscapes.

Further information

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Numbat. Photo: Dilettantiquity Flickr CC by 2.0.

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Further information:

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

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