

Science for Saving Species

Research findings factsheet

Project 4.4

Persistence through tough times: Fixed and shifting refuges in threatened species conservation

In brief

Refuges are vital to the conservation of Australia's threatened species. They are places that species may retreat to during tough times, until conditions ease and they can expand once more into their range. Refuges can work either by reducing the intensity of stressors like drought, fire, heatwaves or disease, or by providing safety from predators and other enemies. This may be for a day or a week, or for years, decades and even centuries. Understanding where refuges are, and how to protect or even create them is therefore essential if we are to prevent extinctions of imperilled species.

Some refuges are easy to identify, such as an artesian spring that helps animals in an arid landscape survive a drought.

But sometimes the most vital refuges shift across the landscape. This makes sense when you consider that Australia is a vast land of droughts, flooding rains and highly variable weather. Refuges can also shift for reasons of becoming the last place where an animal can avoid a predator or a disease.

Australia's national parks and reserves often capture these important places. However, our research shows that the often-shifting nature of refuges means we need to also think about places in the broader landscape that will help threatened species survive now and into the future, and how to promote them. We also need to recognise when refuges alone are not enough to protect species.

Unburnt landscapes as shifting refuges

Patches of vegetation that have remained unburnt for many years – sometimes decades – can be important refuges for many species living in the arid and semi-arid zones.

Many native birds, mammals and reptiles are more vulnerable to predation in recently burnt areas, as cats are highly efficient hunters in places where most of the vegetation cover has been burnt away. For example, endangered birds such as the mallee emu-wren (*Stipiturus mallee*), Carpentarian grasswren (*Amytornis dorotheae*) and night parrot (*Pezoporus occidentalis*) all depend on hummocks of spinifex grass that have remained long unburnt.

Likewise, the great desert skink (*Liopholis kintorei*) and the sandhill dunnart (*Sminthopsis psammophila*) need patches of unburnt spinifex to escape predation by feral cats. In some cases, structural characteristics – like rocks – protect these spinifex patches from fire, and in other cases temporary factors like wind direction determine which areas are burned and which are left unburnt, so that the location of unburnt patches can change over time.

Roosting habitat for night parrots - old unburnt spinifex. Photo: Nick Leseberg



Understanding the problem

Refuges are likely to be crucial to the persistence of some of our threatened species. This is particularly so when species extinction rates in our times are estimated to be a thousand times above what we might otherwise expect, due to threats created by human activity – chiefly, land clearing, changes in land use such as fire regimes, and introduced species.

The research team began by synthesising current knowledge of the role of fixed and shifting refuges for Australian threatened species. We examined the role of these refuges in protecting species against stressors like drought, fire, heatwaves, introduced species, disease, and the interactions between them.

We define a “refuge” as a place that offers individuals or populations of species relief from stressors over time or in space.

This definition helps us to differentiate refuges from remnants, which are places where species have always persisted in an undisturbed way, and from havens, which are places where predators have been excluded, such as fenced exclosures.

Most previous research has focused on refuges that are in fixed places, but there is an increasing understanding of the importance of refuges that shift over time across the landscape. Studying this kind of refuge is more difficult, but vital if we want to enhance or create them to benefit threatened species. For example, while Australia’s nature conservation and Indigenous Protected Areas cover 23% of Australia’s land, habitats outside these protected areas are likely to become essential to helping species to survive tough times.

What we did

Experts from across Australia with specialised knowledge about different ecosystems and kinds of animals were brought together for this project. We synthesised the nature and functioning of the various types of refuges, using examples from diverse environments (e.g., arid zone, woodlands, tropical rainforests), stressors (e.g., drought, fire, heatwaves, introduced predators and competitors, disease) and species (e.g., birds, reptiles, mammals, frogs and fish). Our study recognised that multiple stressors

often affect species in interacting ways, making them difficult to tease apart and treat separately.

The research team considered refuges in terms of a species’ niche: that is, a location (in time and space) where the animal’s needs are met. As these places can change over time, a species may need to move between favourable locations to stay within their niche. A refuge, then, is where an individual’s or a population’s niche will persist even if other parts of their range become inhospitable.

Our findings

We found that, in Australian conditions, refuges often provide greater vegetation cover, water, food availability, protection from predators or some combination of these, than what could be found in the wider landscape.

We identified that refuges arise in two ways through dynamic and shifting processes – patchiness and buffering.

Patchiness refers to the distribution and intensity of the stressor across space. This is particularly the case with “press” stressors, which are persistent, such as urbanisation, and “pulse” stressors, which are sudden, such as flood and fire. Less affected patches, such as mountains, gorges or rocky areas, can act as refuges until more severely affected areas can recover.

Buffering refers to areas that are exposed to a disturbance, but have properties that lessen the impact of the stressor on an individual or a population. For example, gullies can provide refuges for bird species during and after fires when the surrounding habitat is burned. Buffering also provides important refuge from stressors that build gradually over time, such as droughts, when the availability of water at riverbanks becomes vital for many species.

Toxic plants, including the *Gastrolobium* genus, can create refuges for native wildlife from exotic predators without evolved tolerance to the toxins. Many of these toxic plants respond to fire or other disturbance and hence the efficacy of these refuges can potentially be improved by informed land management.

Refuges can also arise through species interactions, such as predator suppression, where the presence of dingoes can create a refuge by suppressing the impact of smaller predators such as cats and foxes. Such refuges can be quite dynamic over space and time, and can have very short time-scales, even hours, such as when cats shift their hunting behaviour to avoid times of peak dingo activity.



Kowari in Sturt Stony Desert Photo: Cat Lynch

Shifting refuges are -- by their nature -- harder to locate than fixed ones. However, we can narrow the search by identifying landscape features within a species' range or places within it where predator populations occur. Methods such as topographical mapping and remotely sensed data can help find these places.

Understanding these mechanisms by which species benefit from refuges can help guide scientists and land managers to create new or artificial refuges. For example, if individuals or populations of a species use a refuge because they can access food there more easily with lower risks of predation, then management options to explore might be either how access to food can be enhanced, or the risk of predation lowered, or both.

Refuges for our times of climate change

In late 2018, bird watchers and scientists alike were surprised to find rare little bitterns (*Ixobrychus minutus*) at Bool Lagoon in South Australia, which is well outside their usual range. The birds were believed to be using Bool Lagoon as a drought refuge due to the very dry conditions in south-eastern and south-western Australia where they usually occur. Even a year previously, mapping of the most essential areas for this species would have been unlikely to include any habitat in South Australia, but this shows how the location of important refuges can change over time. With climate change set to increase the frequency of extreme weather events, we are likely to see this kind of refuge arising even more often.



Little bittern. Photo: Luc Hoogenstein CC BY-SA 4.0 Wikimedia Commons

Recommendations

Key refuges for Australia's threatened species need to be located and protected from habitat loss, for example, through urban development. We also need to ensure that they are not further impacted by other threats. From a management perspective, it is important to understand how individual species use refuges. In particular, the impact of multiple stressors that interact must be taken into account: as we have seen, effective refuges frequently provide relief from more than one stressor at a time.

While some kinds of refuge are likely to be well-represented in parks and reserves, such as steep, high-elevation sites, which can act as refuges against climate change, others have little protection within reserves. These often include refuges found in sites with highly productive soils that are desirable for agriculture, or on land with potential for development, such as on urban fringes. For example, old quarry pits on urban fringes are important disease refuges for the threatened growling grass frog, but these are gradually being filled in for housing estates.

The whats, wheres and whens

To maximise the success of management of refuges, the following questions need to be considered: what action is needed, where it is needed and when it is needed.

Shifting refuges are by their very nature more difficult to incorporate into protected areas and management plans. However, broad-scale management actions such as protecting top predators (i.e., dingoes) and preserving vegetation cover in reserves may help to promote shifting refuges throughout the landscape, with the exact location of these driven by more dynamic processes, such as fire and the movement of predators. We can continue to improve our understanding of the role of shifting refuges, as this can help us make more informed choices about areas to protect that will best promote the long-term survival of species at risk.

Maintaining and enhancing connectivity between places of refuge, and between refuges and non-refuge habitat, will also be a very important management consideration, given that refuges are by our definition places used by a species until a stressor is alleviated.

Recommendations (cont.)

Methods to achieve this may include habitat restoration, maintaining environmental flows, and increasing the size of patches that are unburnt or ungrazed by sheep or cattle to maintain vegetation cover. This might even mean managing kangaroos and wallabies if their heavy grazing is preventing vegetation from recovering. Programs that support increased habitat and biodiversity values on private land, like Landcare, can play a big part in helping native species to survive long-term through providing such corridors of connectivity.

Shifting refuges may also only need management during periods when the area is being used as a refuge. For example at the end of periods of high rainfall in arid regions the number of introduced predators can boom, placing pressure on native animal populations that may be already declining as conditions become drier.

The question of when to take action is particularly critical when it comes to fire management. It is important that fire refuge areas are not burnt at a frequency that prevents the development of old growth vegetation. "Clean up" burns after fires also risk degrading gullies, which protect many species from fire, exposing them to predators while cover vegetation in nearby open areas is regenerating.

Finally, and vitally, we also need to recognise when refuges alone are insufficient to halt the decline in numbers of a species, and where more intensive conservation intervention may also be required.

Burrows enable many animal species to survive the temperature extremes of arid and semi-arid regions, including native animals and feral cats.
Photo: Natalie Briscoe



Additional material

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Further information

April Reside, The University of Queensland, a.reside@uq.edu.au

Diana Fisher, The University of Queensland, d.fisher@uq.edu.au