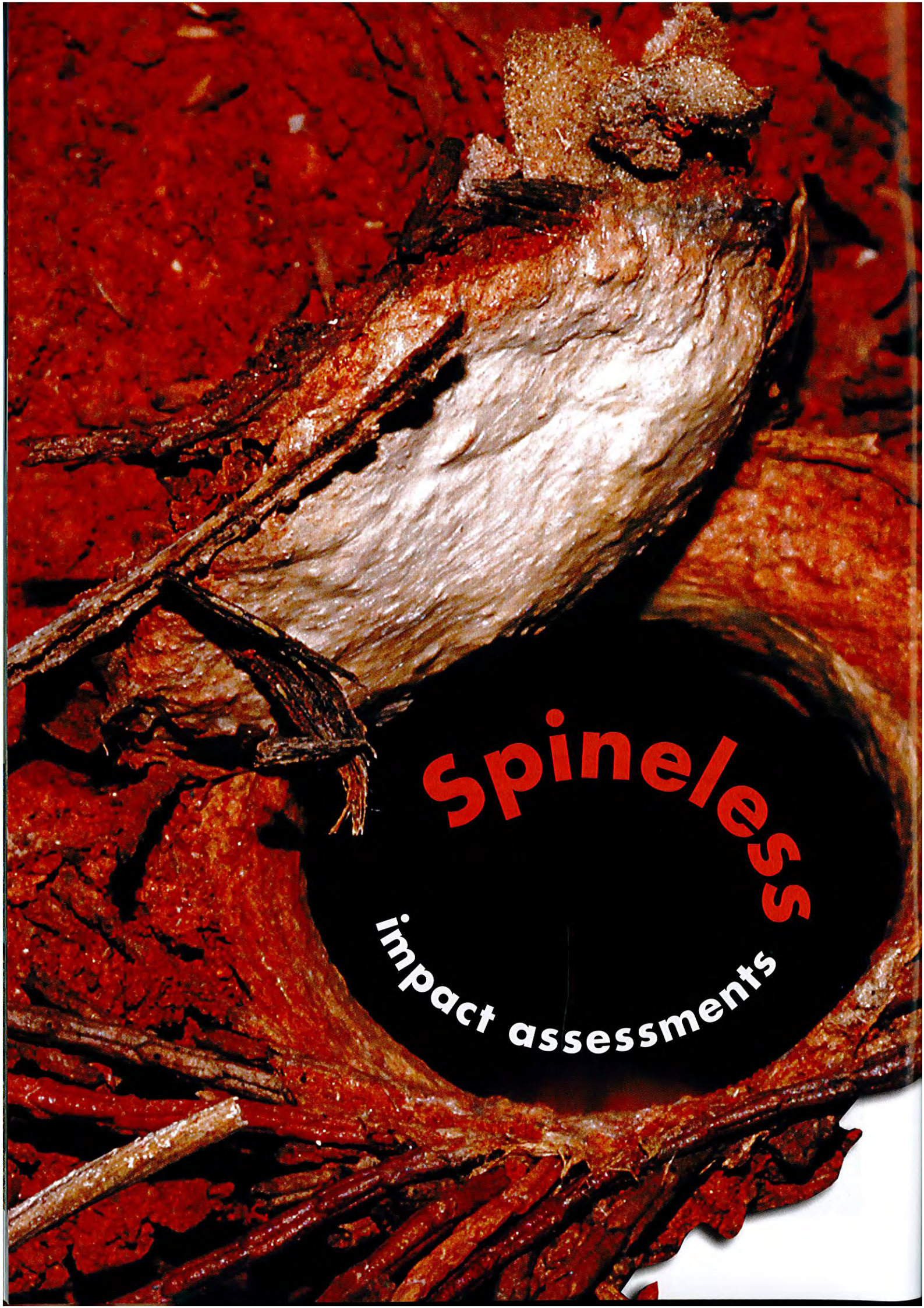
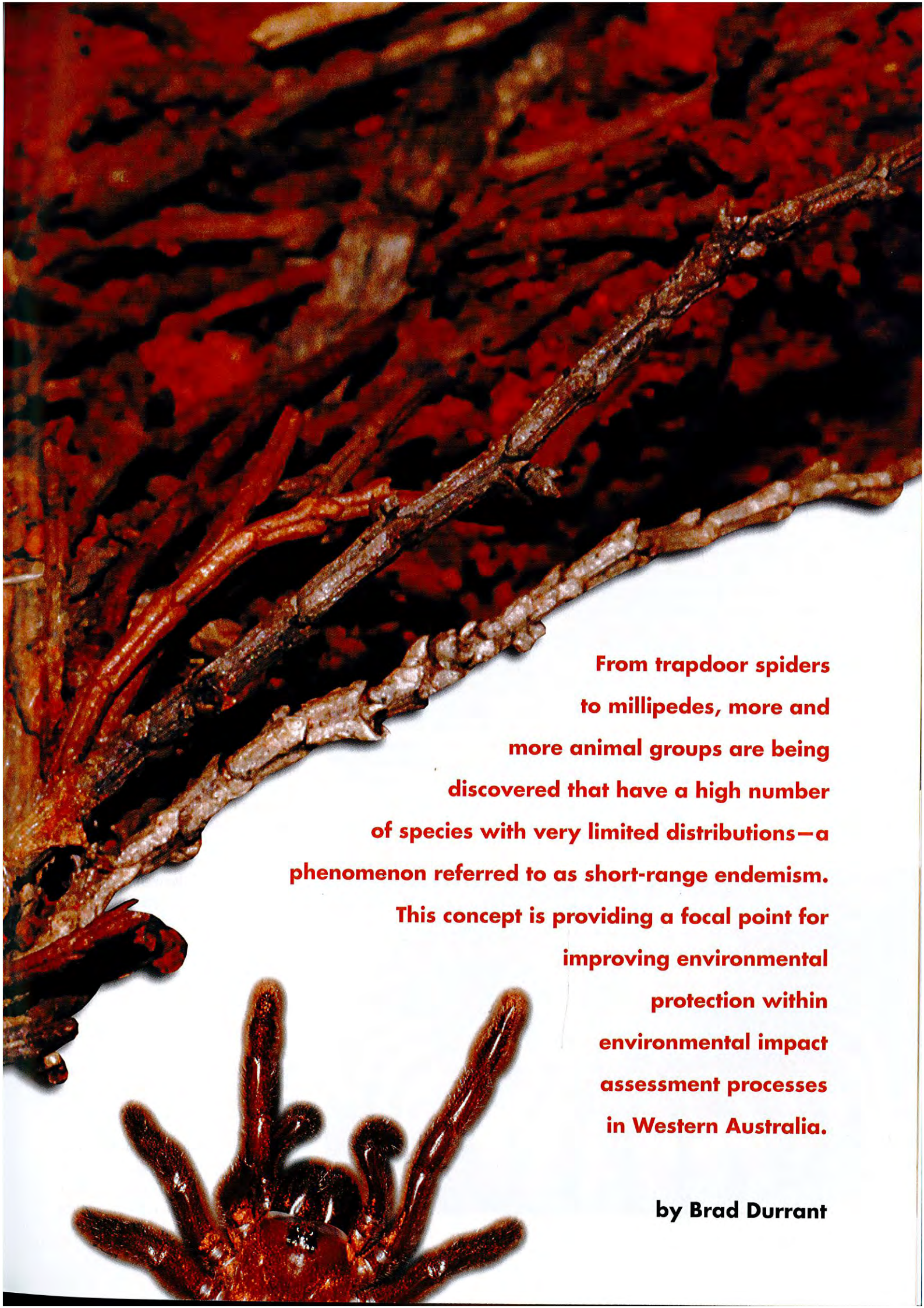

Spineless
impact assessments



From trapdoor spiders to millipedes, more and more animal groups are being discovered that have a high number of species with very limited distributions—a phenomenon referred to as short-range endemism. This concept is providing a focal point for improving environmental protection within environmental impact assessment processes in Western Australia.

by Brad Durrant

All forms of life have limitations on their distribution—environmental and biological factors that prevent them from colonising surrounding environments. The planet Earth represents the broadest example of endemism; no life that occurs on our planet is likely to occur anywhere else in the universe. At the other extreme, there is potential for small pockets in the landscape—such as mountain tops, permanent springs, gorges and islands—to harbour species not found anywhere else.

The concept of short-range endemism is not new and has been around for as long as people have been studying living organisms and their distributions. Recently, however, the idea has provided a focus for improving the capacity of the environmental impact assessment process to contribute to the conservation of biodiversity in Western Australia. The driving force behind this change has been the identification of a number of animal groups over the past 15 to 20 years that have a very high number of species with very limited distributions, and some groups that are made up almost entirely of short-range endemics (SREs).

These SRE groups are primarily terrestrial invertebrates—animals without backbones that live on land—and include arachnids (spiders, for example), insects, snails, myriapods (millipedes, for example) and worms. SREs do occur in other groups as well—freshwater and marine fauna, mammals, birds, reptiles and amphibians—but they are a minority with most species having regional, statewide or even Australia-wide distributions.

In 2002, Dr Mark Harvey of the Western Australian Museum produced a research paper discussing short-range endemism and terrestrial invertebrates, providing a basis for what may be regarded scientifically as a 'short range'. This helped to highlight the importance of this fauna and identified a major deficiency in the environmental impact assessment process at the time. Mark adopted a conservative figure of 10,000 square kilometres (100 kilometres by 100 kilometres) as an approximate threshold for what distribution may be regarded as a short range.

Degrees of endemism

Endemism comes in degrees: sometimes it is very distinct and sometimes it is difficult to discern. The variation in degrees of distinction between habitats can be related to the barriers surrounding an area, whether they constitute a physical barrier or because the surrounding environment is inhospitable. Islands represent a very common and very obvious environment that contributes to endemsim, made so by the fact they are surrounded by water, an environment that most land-based animals cannot survive in, even for short periods of time.

Physical barriers can also play a significant role in restricting movement, so environments such as gorges or mountain ranges can be very important for some species. Gorges are a very good example of restrictive habitats. While they can represent a physical barrier between themselves and the surrounding environment, as well as creating a division between areas, they may form specialised habitats in their own right. The structure of

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Main Trapdoor spider burrow.
Photo – Brad Durrant/DEC
Inset Trapdoor spider.
Photo – Ryan Ellis

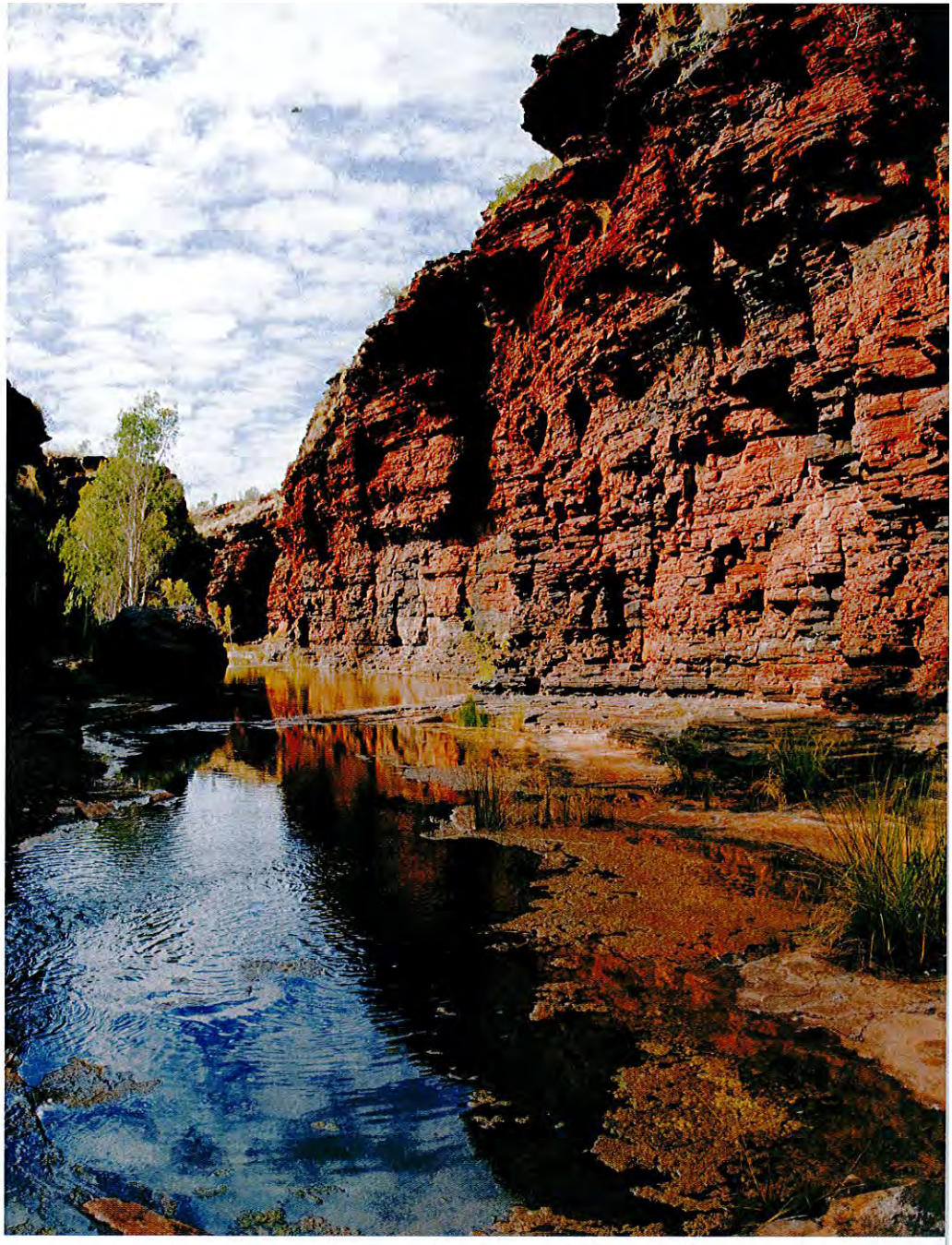
Above Moggridgea trapdoor spider.
Photo – Jiri Lochman

Left Millipede.
Photo – Ryan Ellis

gorges provides a significant amount of protection for animals and their habitats. This protection is primarily in the form of reduced exposure to the elements, particularly sunlight and wind, but also protection from fire. This allows the soil to remain consistently moist, which enables more moisture-dependent vegetation to grow, resulting in a more sub-tropical or tropical habitat than an arid one.

Much of the endemism in WA has been driven by the climatic changes during the Tertiary period (65 million to 1.8 million years ago) when the rainforests that covered the country dried out and contracted, forcing the fauna that relied on these habitats to contract as well, adapt or become extinct. Many species were able to take refuge and establish viable populations. Some species moved underground into spaces and voids or into underground aquifers, evolving into pale, blind animals relying on extra-sensory features to move, feed and mate. Others contracted into protected positions in the landscape, also known as refugia. These refugia provide enough protection from disturbance and exposure to enable these species to survive but the isolation may not allow easy dispersal to other suitable habitats, or to other populations.

The Stirling Range near WA's south coast is a good example of an important landscape feature providing refuge for a number of known invertebrates. These include the Stirling Range moggridgea spider (*Moggridgea* sp.), the palisade spider (*Neohomogona stirlingii*), a giant earthworm *Megascolex* sp. and the Stirling Range rhytidid snail (*Rhytidid* sp.).



Above Gorges are a good example of restrictive habitats. Kalamina Gorge, Karijini National Park.
Photo – Ann Storrie

Biological factors

The size of an animal's distribution can be limited by a number of biological factors, the most obvious being the animal's ability to move. There will commonly be at least one stage of an animal's life cycle where dispersal is a primary goal, usually as a juvenile. Large animals (mammals, birds, reptiles and amphibians) have a greater ability to disperse because of their size and mobility, hence few species in these groups are regarded as SREs. Similarly, most flying insects are successful dispersers because of their ability to fly. Within the spider world, most of the modern spiders disperse easily as baby spiders (spiderlings) using a technique known as ballooning, where light gossamer silk is released from the spinnerets and the spider is carried away with the wind. The lower number of marine and freshwater SREs can be largely put down to the influence of water in providing a suitable medium for moving between areas.

Other factors that can place pressure on species include their growth rate (particularly the time taken to reach sexual maturity) and fecundity, or reproductive capacity (how many offspring are produced). A good example of the restrictions that these factors can place on a group can be found with the trapdoor spiders. The ability to produce large broods of spiderlings is a modern trait and presents a massive advantage to those species that are able to do so. Broods of hundreds of individuals are common in many web-building species. Conversely, the primitive trapdoors may only produce broods of up to a dozen, with this number likely to be reduced further due to predation and natural attrition before the brood even leaves the burrow.

Many trapdoor spiders are very long lived, with females of some species living as long as 25 to 30 years. While this may seem to represent an advantage over other organisms, as an individual female may produce several broods during her life, the time it takes for these long-lived species to reach sexual maturity can be about five to seven years. This means that before they can even begin reproducing, they need to survive several years, much longer than most invertebrates live their entire lives.

So the combination of large broods, short life spans (and the resultant quick maturity) and easy dispersal has provided modern spiders with a major advantage over the more ancestral trapdoor spiders. This advantage doesn't just extend to maintaining or expanding a distribution, but also to the ability to recover from disturbance. Recolonising areas and the reestablishment of a viable population is very difficult when small numbers of individuals are produced which then take years to mature to produce the next generation.

Environmental factors

Short-range endemism in the predominantly arid environment of WA is largely driven by moisture retention and protection from disturbance. Moisture retention can be affected by a variety of different factors, most notably soil type and structure, and protection from sun exposure. This is most evident in the arid zones when looking at the large rangelands. The least amount of exposure throughout the year is on the southern slopes of range systems and hills, which receive direct overhead sunlight during the summer months but are protected during winter because of the change in the angle of the sun. This is most noticeable with the heavier vegetation that tends to occur in these southern positions, compared to the sparse, lower vegetation found elsewhere.

One of the more prominent types of disturbance in WA—fire—can occur naturally or through human intervention, either accidentally or deliberately. Habitats such as gullies and gorges can provide protection from fire but other refugial habitats such as woodlands and springs are usually more exposed to fire. This means they are more prone to being devastated by hot, intense fires that can completely remove the protective qualities of the habitat, potentially rendering some species locally or totally extinct. However, it is also worth noting that fire is a natural and essential part of many habitats in Australia, and that less intense fires that create a mosaic of burnt and unburnt patches play an important role in maintaining and improving biodiversity values.

Pastoral and feral stock also impact on these isolated habitats. Gullies and gorges again afford some protection but heavier vegetation in woodlands and permanent water attracts livestock, removing much of the protective overhead vegetation and trampling and disturbing the soil, particularly around the base of trees where leaf litter provides most of the protection for many SREs.

Both these disturbances can be particularly devastating for trapdoor spiders, with fire removing the door to their burrow and most of the protective leaf litter and overhead vegetation, leaving no material to rebuild. And, if the spider manages to survive the heat generated from the fire in the first instance, the effect of the fire continues as it reduces the numbers of prey species. Similarly, grazing animals remove vegetation, move leaf litter away from the base of trees, kick and trample burrow doors and cave in burrows.

Environmental impact assessment

The environmental impact assessment process is used to assess the likely impacts of a development proposal on the environment and, if there is likely to be a significant impact, formulate conditions to be applied to the project to ensure the environment is protected. The *Wildlife Conservation*

Above Department of Environment and Conservation volunteers search for short-range endemic invertebrates in Karijini National Park.
Photo - Brad Durrant/DEC

Left Land snails.
Photo - Jiri Lochman

Above Moggridgea trapdoor spider habitat in the Stirling Range.
Photo – Marie Lochman

Below Pseudoscorpion.
Photo – Ryan Ellis

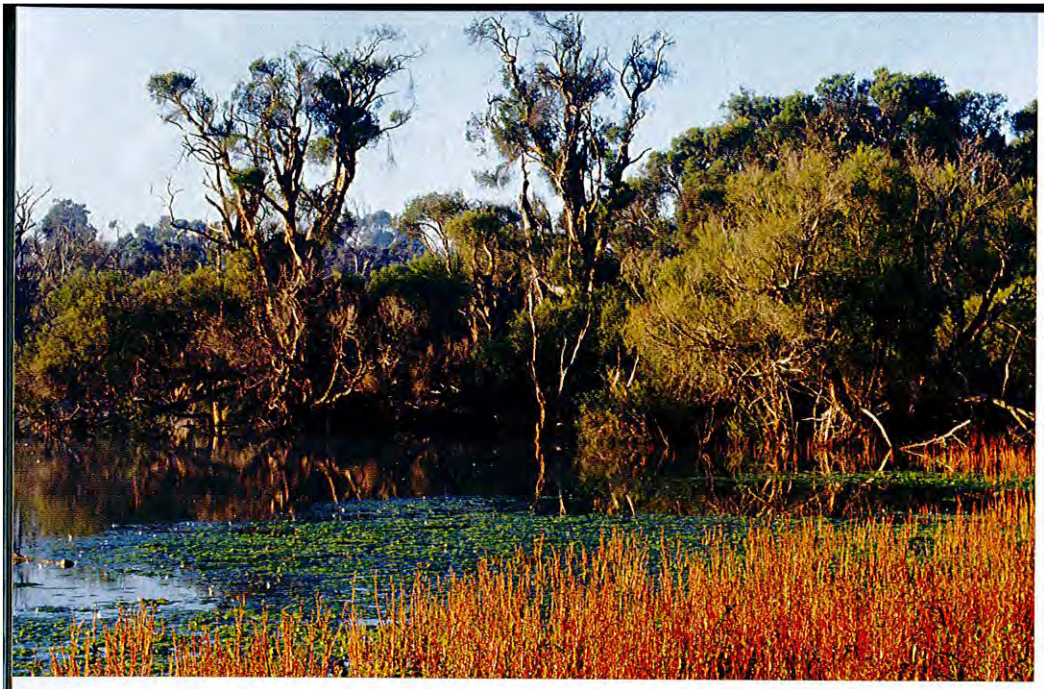
Act 1950, WA's flora and fauna species protection legislation, underpins the approach to the conservation of species within the environmental assessment process. Species listed under the Act remain the primary focus of environmental conditions for many environmental impact assessments.

Beyond listed species, the focus of most environmental impact assessments had been almost entirely on vertebrate animals, plants, threatened ecological communities and species that have been listed as threatened or 'priority' and in need of further study. Over the past several years, subterranean fauna have become an important consideration in many of these assessments and the past few years has seen SRE invertebrates become important as well.

In 2009, the Environmental Protection Authority (EPA) released a guidance statement for SRE fauna (Guidance Statement 20), which provides an overview of fauna groups warranting investigation as potential SREs, habitats to focus on, and an overview of sampling techniques and issues. Five groups have been highlighted: trapdoor spiders, millipedes, scorpions, pseudoscorpions and land snails. These groups were chosen for a few reasons: they all represent groups with high levels of short-range endemism, there are taxonomic experts available to identify them, largely at the WA Museum, and they are all reasonably easy to sample.

There are two primary functions of SRE investigations undertaken as part of impact assessments. Firstly, they are focused on providing data aimed at demonstrating with some confidence that none of the SRE species present in the project area will be made extinct as a result of the development, taking into account both direct and indirect impacts. This requires a clear demonstration that the species found within areas that will be affected by the development are also found outside in viable populations, or are highly likely to occur elsewhere. This can be difficult to demonstrate as surveying issues can produce patchy results, making the true distribution of the species difficult to ascertain. The fact that many species have not been collected before also adds to the difficulties.

The WA Museum plays an invaluable role in overcoming this taxonomic roadblock, providing most of the taxonomic expertise and housing specimens of thousands of WA animal species as WA's animal 'library'. The museum's role as a central depository is absolutely critical to the environmental impact assessment process, as only a centralised collection will allow for a proper assessment of a species' endemism and provide material for



Left Wetlands such as Carine Swamp in Perth may harbour short-range endemic species.
Photo – Marie Lochman

Below Slater.
Photo – Brad Durrant/DEC

taxonomic research. Molecular studies also play a valuable role in assessing species distributions but have limitations without the taxonomic perspective.

The other primary function of surveys is providing some context about habitat. Impact assessments can never take into account every living organism in any given area, but changes in vegetation type or structure can be an indication of other environmental changes—such as position or soil variations—which can point to important habitats, or possibly refugia. With this in mind, the use of SRE distribution information can provide a clearer understanding of whether a particular habitat is an important refuge, both for the species detected during the sampling, and for other species dependent on the habitat that may not have been collected.

Another important issue that has been emerging from recent environmental impact assessments relates to known rare and threatened invertebrate fauna. There are a number of species of terrestrial invertebrates that are currently listed as threatened in WA. Many of these fall in the potential SRE invertebrate groups mentioned; in particular, certain trapdoor spiders, land snails and millipedes are listed as either threatened or 'priority' species. However, some don't fit these groups, such as a number of flying insects that are listed as threatened, including bees and moths.

Anthopogenic endemism

Human-induced restriction in species' range through habitat loss and fragmentation (also referred to as 'anthopogenic endemism') is a major issue in heavily populated areas and agricultural regions. Many of the invertebrates that appear on the list of threatened fauna are there because they occur in the Perth metropolitan area or the wheatbelt and their distributions have been massively impacted by land clearing and habitat destruction. Threatened fauna are treated differently from other groups in environmental impact assessments. If a threatened taxon is likely to occur in the project area, a targeted survey is required and, if found, a comprehensive survey is carried out to determine the extent of the impact on the species.

One recent example of this is the shield back trapdoor spider (*Idiosoma nigrum*) which has been the focus of a number of mining proposals in the midwest because of its propensity to inhabit the gullies and southern slopes of some of the iron ore-rich ranges. Several companies have carried out comprehensive surveys of their tenement areas involving counting of burrows, which are fairly distinctive. This has provided a massive increase in available data for this species and allowed the EPA to make decisions on the significance of proposal impacts with greater confidence.

The use of SRE invertebrates in impact assessments has provided a more comprehensive approach to determining the true impact of a development on the local environment. It has increased the chances of identifying important refugia whose significance may not have been obvious through the exclusive use of larger animals or plants. The process of using SREs in assessments is still evolving, as the knowledge gaps that are commonplace when working with invertebrates continue to present problems. The large number of SRE surveys currently being undertaken is providing much needed data that will, over time, feed back into and further enhance the information available to confidently assess proposals, particularly with regard to the identification of animals and sampling protocols.

However, much of the ecological and environmental context for these species is not gathered as part of the impact assessment process and will continue to be a significant gap in our knowledge. This is particularly evident with threatened fauna, where very little is known about the behavioural and ecological factors that are integral in providing that protection. Much of the current approach to assessing impacts on threatened invertebrate species involves the use of basic knowledge of broad taxonomic groups, general assumptions and anecdotal evidence to protect animal species that are known. However, there are likely to be many invertebrates—both SREs and threatened—on which human activities and development will continue to put immense pressure. If there was ever a time when further research on these animals was desperately needed, it is now.

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Volume 26 Number 2 SUMMER 2010-11

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Regulars

Publishing credits

Executive editor Madeleine Clews.

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Scientific/technical advice Kevin Thiele, Paul Jones, Keith Morris, Michael Rule.

Design and production Tiffany Taylor, Lauren Tyrrell, Peter Nicolas, Gooitzen van der Meer.

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Phone (08) 9334 0296 or *fax* (08) 9334 0432.

Subscription enquiries
Phone (08) 9219 8000.

Prepress and printing GEON, Western Australia.

ISSN 0815-4465

Please do not send unsolicited material, but feel free to contact the editors.

Published by the Department of Environment and Conservation (DEC), 17 Dick Perry Avenue, Kensington, Western Australia.

Visit DEC online at www.dec.wa.gov.au to search the *LANDSCOPE* catalogue.

Department of
Environment and Conservation