Utility seals a berth on

Are all species equal?

Ecologically, all species are not created equal, Dr Brian Walker, chief of CSIRO's Division of Wildlife and Ecology says.

Some are determinants or 'drivers' of the ecosystem to which they belong. Others are 'passengers'. Removing the 'drivers' causes a cascade effect, but losing passengers hardly changes the rest of the ecosystem.

Walker says a knowledge of ecological redundancy is essential to evaluate a decline in biodiversity and that we need to know which aspects of biodiversity and which kinds of species are most important to ecosystem function.

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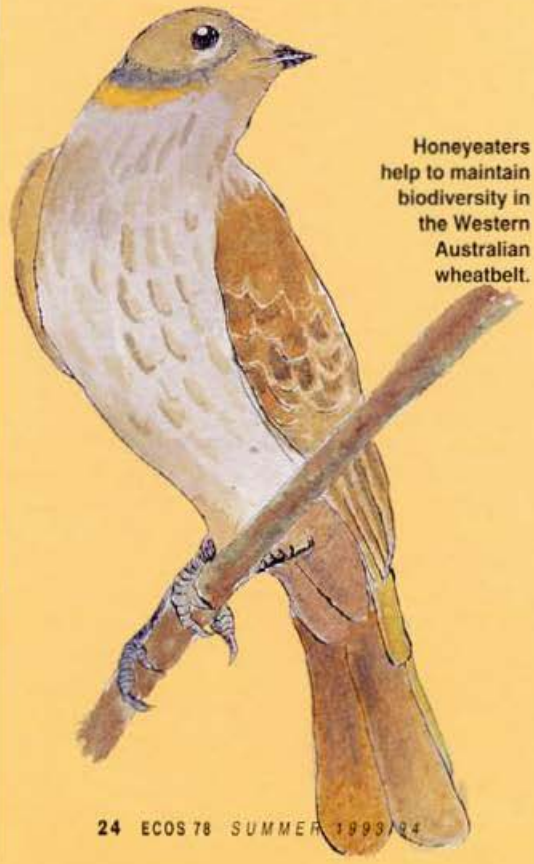


Honeyeaters help to maintain biodiversity in the Western Australian wheatbelt.

Bryony Bennett

Understanding the functions performed by each species is central to determining their importance in an ecosystem.

Setting and meeting the conservation goals of a region is likely to cause plenty of headaches for landscape managers, particularly in the face of declining resources. Priorities must be set to protect biodiversity. But who decides which species are the most important? And is a focus on species the best way to minimise species loss anyway?

Many ecologists say no.

The best way to minimise species loss is to maintain the integrity of ecosystem function, according to CSIRO Division of Wildlife and Ecology chief, Dr Brian Walker. This view is presented in his essay 'Biodiversity and ecological redundancy', published in the March 1992 issue of *Conservation Biology*.

Solutions to global biodiversity problems will ultimately be based on cost-benefit analysis, Walker says. To assist management and political decisions relating to biodiversity, scientists need to address the issue of functional diversity and ecological redundancy in community composition.

Walker says this requires the development of a functional approach to describing biological composition, rather than relying on conventional taxonomy alone. Placing equal emphasis on every species is 'ecologically unsound and tactically unachievable', he says.

Ecosystem functioning refers to the capacity of an ecosystem to capture, store and transfer energy, carbon dioxide, nutrients and water. These are primary processes on which human life depends.

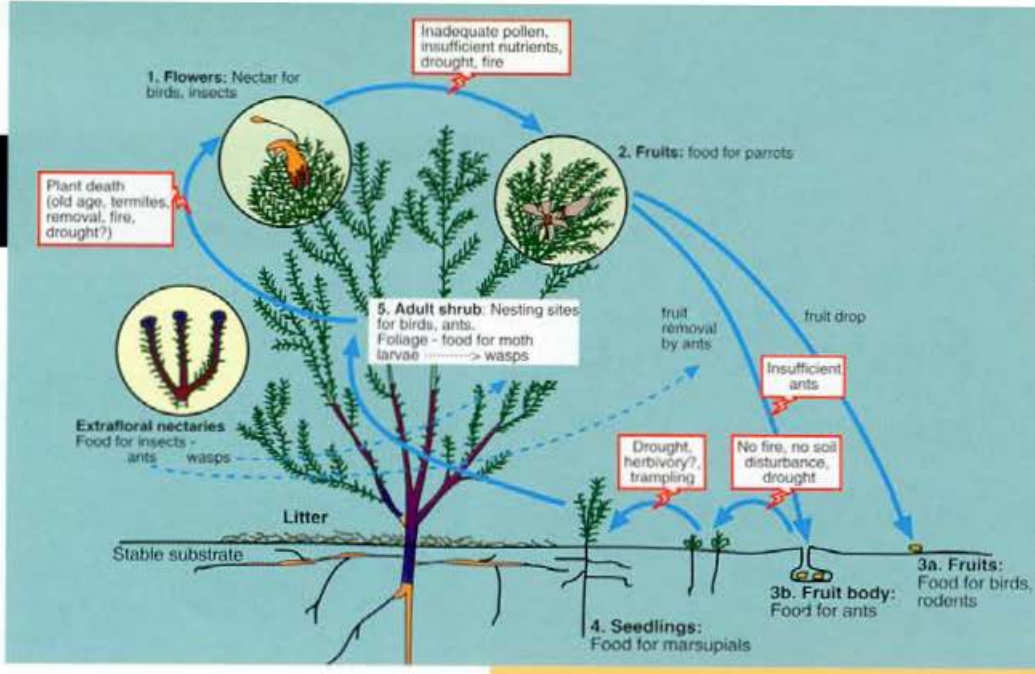
Within these primary ecosystem processes are other population and community-level processes which ensure the continued functioning of the ecosystem. For example, nutrient cycling in an ecosystem may depend on factors such as the response of the plant community to disturbance, grazing by herbivores, nitrogen-fixing symbioses and plant/pollinator interactions.

When considering the function of biodiversity in the ecosystem, it can be useful to group species according to their ecological role. The grouping of species into functional types raises the issue of redundancy or sub-stitutability (the extent to which species in functional groups may be interchangeable). This in turn allows identification of functional groups in which there is little or no redundancy (see box story).

Many functional interactions between species, such as the grazing of plants by herbivores, can easily be seen occurring in an ecosystem. But other relationships are more complex and less visible. For example, micro-organisms add to the functional complexity of ecosystems. Some decompose organic matter, while others release nutrients such as nitrogen from inorganic sources, assisting nutrient uptake by plant roots.

Fungal species (mycorrhizae) form symbiotic associations with thousands of Australian plant species by infecting the surface rootlets and modifying their morphology and function. Their presence aids nutrient uptake by the roots, a particularly useful function when the soil is infertile.

Plants play a crucial role in the ecosystem because they transform non-living elements into the living tissue, which is the basis of biodiversity (such as in the process of photosysthesis). Robert Lambeck, a research scientist at the Division of Wildlife and Ecology at Perth, says the importance of fauna, however, is based primarily on interactions between the living components of an ecosystem.



Major events in the life cycle of *Adenanthos cygnorum*, highlighting the interactions between various animals and the plant. The red boxes indicate the reasons that a particular function may fail. Ants and nectarivorous birds comprise keystone guilds for the plant. *(Reproduced with permission from Surrey Beatty Pty Ltd.)*

In the book, *Biodiversity of Mediterranean Ecosystems in Australia*, Lambeck explains that animals mobilise the nutrients and energy which are 'locked up' in other organisms. This speeds the circulation of elements within a system and the pathways by which they move.

The attributes of the animals present — their relative abundance and interactions — rather than the number of species are important to ecosystem functions, Lambeck says. High biodiversity increases the chance of critical components being represented, but if these components are missing, particular functions will cease.

A suggested approach

To analyse the functional relationships between biological diversity and persistence in an ecosystem it is necessary to consider biodiversity in terms of functionally different kinds of organisms, Walker says.

Looking at the way a species regulates ecosystem processes helps to define its functional type. Defining species in this way focuses attention on the processes that maintain ecosystems and their community function. It also indicates how changes in the relative or absolute abundances of the functional groups concerned, and their patterns of distribution, will influence these processes. Walker sugests the following approach:

1. Identify the most important processes in a system and then classify the biota into functional types or 'guilds'. Then further sub-divide the species in a guild on the basis of important functional attributes. If this cannot be done and there are still several species in the group, some ecological redundancy within the guild is likely.

2. Determine the number of species in each guild. Those represented by only a few or even a single species are clearly unable to withstand any loss of species and need immediate conservation.

3. Further examine the interactions among the species in each guild. Complete functional redundancy only occurs if, following the removal of one species, there is density compensation (increased abundance) among the remaining species.

4. Consider the relative importance of the functional groups. Examine how a change in abundance of a functional group directly affects ecosystem and comunity processes. How would such a change influence the net effect of the biota (through changes in functions such as predation, dispersal, herbivory, decomposition, nutrient cycling and biomass accumulation)?

Walker does not advocate a complete switch from one taxonomic approach to another. He says taxonomic distinctness is a valuable tool for helping to choose among many different areas to ensure that maximum biodiversity is included (for example, in a reserve network). The functional group approach, however, focuses on which species are of major concern in managing, or identifying appropriate boundaries for a particular region to minimise the loss of biodiversity. The two are complementary in devising an overall conservation strategy.

The notion of functional groups has yet to be applied in a detailed way to particular ecosystems. Walker says given the disappointing progress in achieving programs using individual species approaches to biodiversity, ecological redundancy deserves serious attention.

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In particular, identification of functional groups containing little redundancy may help to direct conservation priorities. Functional groups with little or no redundancy will warrant conservation. It is also likely that some species have no functional analogues and are hence 'keystone' species. These species must be identified because the loss of keystone species can result in major changes to the function and composition of the community in which they occur.

For example, in the central wheatbelt of Western Australia, *Banksia prionotes* provides nectar for honeyeaters for a limited period of the year when there are virtually no other nectar-producing species in flower. This banksia is poorly represented in the central wheatbelt, but is a critical resource for honeyeaters. The honeyeaters in turn help to maintain floral biodiversity.

Many of the region's plants use honeyeaters as vectors for pollen transfer and a reduction in bird numbers could reduce plant reproductive success. For example, *Banksia prionotes* will not set seed unless pollinated by birds, and in another wheatbelt species, *Hakea scoparia*, the exclusion of birds affects follicle formation. The loss of such nectar-producing plants could have an impact on the honeyeaters' survival.

No other species perform the same function as *B. prionotes* in the central wheatbelt region. This factor raises its importance in the ecosystem. The species does not play the same critical role in coastal parts of its range, where another banksia species *(B. menziesii)* flowers simultaneously.