

# Terrestrial Invertebrates and Ecological Restoration

*Lance Wilkie, who has a research background in Applied Entomology and works in the Australian Museum's Centre for Biodiversity Conservation and Research (CBCR,) provided a comprehensive overview of the study of invertebrates and outlined the opportunities and the barriers for using invertebrates as indicators of ecosystem health. He gave examples of ongoing and new projects. This is a short summary of his presentation.*

The CBCR, set up in 1996 for biodiversity research, has a major focus on terrestrial invertebrates. In terms of biodiversity, invertebrate species are numerically dominant and make up most of the abundance and the composition of species on earth- possibly as much as 99% if you include undescribed invertebrate species.

Invertebrates are animals that lack a backbone. Instead, they are supported by exoskeletons of some form or other. Invertebrates play critical roles in performing many ecosystem functions, eg

- Decomposition processes, including the breakdown of waste products into useable nutrients, eg dung beetles.
- Maintenance of soil structure and fertility.
- Regulation of other species populations, eg. *Cactoblastis*.
- Pollinators for the majority of flowering plant species, eg flies, wasps, beetles

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***It is not about taking care of invertebrates, but more about them taking care of us by performing many of the essential processes required to improve habitat condition.***

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## **Monitoring ecosystem health:**

### **Advantages of using invertebrates**

- Numerical dominance: lots of data quickly with comparatively little effort;
- Sensitive indicators of disturbance: environmental responses will occur at smaller levels of impact;

- Shorter life spans: changes in birth rates become apparent far sooner than in vertebrates;
- Very small: more limited dispersal ability than vertebrates with less ability to respond to poor conditions by emigration.

**Disadvantages of using invertebrates:**

- Time consuming work: lab work, sorting, ID, labelling etc– typically only look at a subset of the material collected;
- Specialist equipment required at high cost;
- Sampling design needs care, eg how big an area should be sampled? How often? Using what microhabitats and sampling techniques?
- Lack of available expertise: invertebrate taxonomists not a common species.

***If you wish to include species level inventories of invertebrates it is strongly recommended that you seek taxonomists to participate in the project.***

**Techniques used for collecting terrestrial invertebrates**

There are active or passive techniques for collecting. Passive sampling techniques include use of pitfall traps, flight intercept traps, or leaf litter collection. These provide the maximal amount of material for the least amount of effort per sample and are the easiest to standardise for statistical sampling. Active sampling includes collecting by hand, sweep sampling (using a long, soft net) or beat sampling, using a shallow tray and stick to beat the tree and catch the fall out.

Active sampling techniques may introduce bias into data sets by differences in sampling intensity between individuals & variability of sampling intensity across sites.

**Using invertebrates in restoration projects**

Current approaches include both survival and/or enhancement of rare or threatened species, (eg Bathurst Copper Butterfly) and statistical comparisons to identify increase in overall diversity of the area. In the former instance it is important to consider whether the particular invertebrates really rare or whether they are just not caught often, and if they are rare you don't want to kill them.

Statistical analysis is the most common invertebrate study used, eg in mine site rehabilitation, burning and grazing & habitat fragmentation studies with groups such as ground-dwelling

spiders, collembola, oribatid mites, and beetle groups. In Australia, ants have been among the most commonly used groups. Groups chosen usually have manageable diversity, are functionally important and often flightless. Statistical studies can examine many species together and involves lethal sampling. Standard effort is needed for each sample collected, eg equal numbers of samples taken at each site. Sufficient numbers of sites have to be sampled, over a sufficient period of time. Care needs to be taken to avoid sample bias - this may cause misleading impressions in statistical results leading to mistaken conclusions which may in turn lead to poor management. Analysis can be quite complex, and results can be dramatically effected by poorly designed studies.

### **Examples of CBCR Research Projects**

**1. Bitou Bush Invasion of Coastal Dunes Study** Terrestrial arthropod diversity is commonly thought of as being positively correlated with plant diversity. Weed invasions represent a threat to arthropod communities not just by replacement of palatable native vegetation, thus depriving herbivorous insects a food resource, but also by affecting the architectural composition of the habitat. This study investigates the impacts upon selected arthropod assemblages of habitat invasion by bitou. Sixteen sites at four localities between Forster and Budgewoi on the NSW mid-north coast were used. Changes in habitats undergoing invasion by bitou bush were compared to similar weed-free habitats. Changes in invertebrate species richness, abundance and faunal composition were all examined, in conjunction with the physical changes that occurred in the habitats themselves. Evidence has been found to suggest that species richness may decline as the overall infestation in a park gets heavier, but no real differences were detected between invaded and uninvaded sites within a locality. Also, there was evidenced for distinctive arthropod fauna associated with particular plant species within a habitat, particularly *Leptospermum laevigatum*. Furthermore, these fauna were often very distinct from the fauna associated with bitou bush.

Aerial application of herbicide was also examined and did not cause a detectable change in invertebrate species richness or abundance but there was evidence detected of a marked compositional change in certain species groups most notably the beetles living on the plants and the ground dwelling spiders.

**2. The impact of rodents on plants and insects on Lord Howe Island** The aim of the project is to gain an understanding of the processes by which rodents may affect plant and

invertebrate biodiversity. Rodent-proof experimental exclosures have been constructed which will be used to investigate what happens when rodents are removed. The study is expected to go for 2 to 3 years. It will look at the changes in the number and type of insects and spiders found in the exclosures. All seedlings in them will be monitored for mortality and recruitment and existing plants measured. Seed predation will also be a key element to the study.

**3 The effects of groundwater levels and contaminants on burrowing arthropods.** The CBCR was first contracted by Coleambally Irrigation Area to conduct a faunal inventory of the remaining native vegetation patches in the area. But the project has since extended to examine the effects on burrowing arthropod fauna of impacts such as high water tables and salinity levels in groundwater. Burrowing by arthropods is beneficial in semi-arid environments, maintaining soil health and providing stability of microclimate and protection from dessication.

### **Future Research Directions**

**The Barriers** Essential problems in using invertebrates for monitoring remains the time lag between data collection and availability, as well as impacts on the sampling adequacy, which in turn impacts on the statistical power of a study. In order to be effective for management, monitoring measures should be accurate, precise, and available almost immediately. To date, many projects involving invertebrates have concentrated solely on establishing links between an environmental stress of some type, and numerical changes in selected invertebrate groups. The changes identified tend to be very broad, and the implications for conservation or rehabilitation are still not clearly identifiable. eg. the ant-habitat complexity relationship.

**Upper Hunter River Rehabilitation Initiative** This is a research-focussed, large scale rehabilitation project, involving riparian revegetation and instream works. The research seeks to understand the relationship between physical and biological patterns and processes at different spatial and temporal scales, and their response to the rehabilitation works. Different aspects of the restoration process, including changes to the vegetation, the aquatic fauna, hydrology and geomorphology of the system are all subjects of research projects. The CBCR project, being undertaken by a PhD student, adds terrestrial invertebrate fauna to this list.

Habitat rehabilitation projects are undertaken on the assumption that replacing invasive weed species with native plants restores a biologically complex ecosystem. This however remains untested. The proposed project aims to investigate the development of invertebrate

communities in the early stages of a major rehabilitation project and use this to develop and validate suitable long term biodiversity monitoring methodologies. Riparian invertebrate assemblages have not been studied in Australia.

The proposed project has two interdependent themes: to understand the invertebrate responses to habitat rehabilitation by collection and analysis of species richness/abundance, and to identify and validate the suitability of indices of invertebrate biodiversity.

Invertebrate groups will be selected on the basis of their diversity, ease of collection, ease of identification, availability of taxonomic expertise for quality control, representation of a variety of ecosystem functions, and representation of a variety of functional guilds, such as predators, parasitoids, herbivores, and detritivores.

The responses of invertebrates sampled in the experimental design will be used to verify the accuracy of potential field indices. One of the major shortcomings of indices at present is their lack of validation, despite widespread use.

Community groups will be included in the field sampling program to test the potential of the various field-based biotic indices to be trialed. They will provide valuable input into the usefulness of each index as a management tool that can be easily used by non-specialists. Examples of potential indices include riverbank burrow density, visual inspection of herbivore load on plants, damage levels to fruit and flowers, and field surveys of butterfly diversity. Because collection of this data is less labour intensive than lethal sampling techniques and requires minimal laboratory post-processing, it can be conducted more frequently.

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