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EDITORIAL NOTES

Understanding the requirements of the insects we seek to conserve

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The major, universal, needs for insects are 'habitat' and 'critical resources'. Sustaining these (in conjunction with threat control) is the core of species-level conservation management. Both these terms thus need to be understood clearly, and have respectively been defined most frequently in terms of 'a place to live' and 'the other obligate needs' of a taxon. Recent thoughtful commentary by Dennis et al. (2003, 2006) has broadened appreciation that these are not really distinct or exclusive, and that 'suitable habitat' for a species is determined in large part by the spatial and temporal juxtaposition of the suite of resources (food, microclimate, vegetation, and others—collectively the 'consumables' and 'utilities' of Dennis et al. (2006)) needed by that species, and so transcends the more usual vegetation-based definitions of habitat across the landscape (Dennis et al. 2006). This approach integrates the attributes of place and other resources to indicate the features desirable or obligatory for a focal species on a site (patch), and thus the target desiderata for management such as restoration or enhancement of patch quality. It emphasizes also that knowledge of critical resources, based on detailed autecological study, underpins effective management extending beyond simply 'locking up' a site as a reserve for that taxon. For well-known taxa, such as the butterflies of western Europe, this principle is well established (Van Swaay and Warren 1999). As Maes et al. (2006) commented "Habitat is not just a convenient term or label, but requires fundamental understanding to underpin the conservation of insects in a rapidly changing environment".

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That understanding is often elusive—hence the major research component needed as the initial phase of many insect management plans, especially for less understood groups and in much of the rest of the world. It may not even be clear, except in the most general terms (such as documented larval food plants) what any particular species requires in order to survive, which resources should be managed on sites, and what the limiting conditions to their use may be. Practical management necessarily devolves on patch conservation and sustaining these more obvious resources. A more serious implication arises for those species that we know only from single sites or from a few widely separated areas, for which there is no information, other than that the species persists there, on the real quality or suitability of the occupied patches. The management target then seeks to replicate, emulate, and restore and enhance the features that we deem critical for the insect's survival on those sites.

In many such cases in Australia, these sites represent the remaining refuges for the species, remnants of a broader range now reduced and fragmented through changing patterns of land use. We have no way of being certain that the conditions they manifest are optimal, or distinctly less so as the only places where the species has been able to 'hang on', without necessarily thriving. Many species known from single or few sites are putatively narrow range endemics and no comparison with 'obviously thriving' or undisturbed populations is possible; these have not been found, and may not exist. The only conservation option is thus to use 'what we have' as a conservation model, and to apply a combination of common sense, corporate knowledge and guesswork to evaluate the risks and consequences of any actions we take, without the luxury of being able to undertake replicated trials of management protocols. It is thus also vital to pursue the outcomes through monitoring, and to ensure that management is adaptive or responsive to increasing ecological understanding—but also to be aware that our target models may represent only marginally suitable regimes. Transfer of such generalized management protocols uncritically to other patches/sites/populations of the same species may have serious shortcomings.

Two Lepidoptera of current conservation interest in Victoria exemplify some of these strictures, in rather different ways. Similar examples could be multiplied ad nauseam.

The Eltham copper butterfly, *Paralucia pyrodiscus lucida* (Lycaenidae), occurs in three widely separated areas of the state (Braby et al. 1999), where larvae feed on a single plant species, *Bursaria spinosa*, and are tended by ants of the genus *Notoncus*. The areas are large rural sites (Kiata, Salisbury, both in western Victoria), large periurban sites around Castlemaine (central Victoria), and very small urban remnants surrounded by housing, in eastern outer Melbourne. The last are isolated from each other, and management is focused on the qualities of the individual sites, each treated as a unique environment supporting an independent butterfly population. The size of the urban remnant sites necessitates intensive continuing management to counter the effects of succession and to assure availability of *Bursaria*. The butterfly is there essentially conservation dependent.

On the larger sites, *Bursaria* is very patchy in incidence, and is tracked by the butterflies dispersing between separated patches, possibly inducing a microscale metapopulation structure. On smaller sites, this dispersal pattern is impossible. The optimal pattern and condition of *Bursaria* are unknown; the caterpillars are found most frequently on small stunted plants, but Endersby (1996) believed these to be a consequence of overgrazing rather than a distinct plant phenotype, and plant selection represents the caterpillar's lack of mobility. The management aim for ensuring *Bursaria* availability is thus itself difficult to define, and countered by the solace of planting additional stocks, coppicing overgrown plants, and retaining small plants in the population.

Bursaria and *Notoncus* are both much more widespread than *Paralucia*, and co-occur in many places where the butterfly is absent. Some such sites appear entirely suitable for the butterfly, with the influences of soil quality and permeability, microclimate (insolation, aspect, and other factors) remaining to be clarified, as a prelude to possible translocations in the future; at present these are considered 'high risk', not least because of the unknown vulnerability of any donor population.

The golden sun-moth, *Synemon plana* (Castniidae) occurs on remnant native grasslands (Douglas 2004; Gibson and New 2007), on which subterranean larvae are thought to feed on roots of the native grass genus *Austrodanthonia*. Study of one population in central Victoria identified *Austrodanthonia* as a critical resource and led to a management prescription of restoring sites to include at least 40% cover with these native grasses in order to sustain the moth (O'Dwyer and Attiwill 2000). As with *Paralucia*, most of the known populations of the moth are on very small remnant sites, of a few hectares or less. However, recent surveys have revealed also populations on sites that appear to be very degraded and to support very little *Austrodanthonia*. Braby and Dunford (2006), from surveys of *S. plana* in the Australian Capital Territory, suggested (based on presence of pupal cases protruding from the ground) that caterpillars may also feed on the exotic Chilean needle grass (*Nassella neesiana*), a target for eradication on some Victorian grasslands. Biological knowledge of the sun-moth is based almost entirely on the adult stage, and little is known of developmental requirements or the features of critical resources.

One approach to site evaluation for *S. plana* has been to 'rank' the sites in suitability in some way, notwithstanding the considerable difficulties of assessing population numbers as an 'index of suitability' (Gibson and New 2007), but even suggesting the environmental features to be ranked (or quantified) is difficult. The following features are amongst those inferred to influence the moth's wellbeing: proportion of bare ground; cover of *Austrodanthonia*; extent of exotic grasses and other weeds; height of vegetation; extent of shading; slope and aspect (insolation). Weather conditions such as cloud cover, temperature and wind speed determine moth activity as the only available index for correlation with these and other site variables.

A similar suite of variable features for *Paralucia* would include soil type; cover, height and age of *Bursaria*; abundance of *Notoncus*; extent of weed cover; extent of canopy cover; aspect and insolation; floral nectar resources; presence of honeydew-producing Homoptera on *Bursaria*; and 'openness' of site for adult dispersal. Braby et al. (1999) concluded 'Although the Eltham copper has received much more attention than any other Australian lycaenid, the gaps in our knowledge are sobering in relation to attempts to understand and conserve other more seriously threatened but much less studied Lycaenidae in Australia.'

More generally, it is commonly not clear why *Paralucia*, *Synemon* and many other species of conservation interest occur on only a, sometimes small, subset of the apparently suitable habitat patches across a landscape and in which the needed resources (as we know them) are present.

The above considers simply the 'environmental background' to the species wellbeing, and does not include such factors as any differential impacts of predators or parasitoids on different sites, or the anthropogenic threats that must be managed—and against which intrinsic site suitability must be appraised. The features fostering site suitability may be obscured by site-specific threats, for example. Nevertheless, major lessening of site/habitat/resource features needed by a target species should trigger management, with that management becoming increasingly focused and effective as knowledge accumulates. Without knowledge, management is inevitably generalized and may be 'high risk', other than in assuring site security; with adequate knowledge, management may be largely site-specific but aim also to assure the critical resources for species on all the sites. As Dennis et al. (2006, p. 1956) emphasized, resources cannot be mapped and assessed unless we know what they are. All too often, we still do *not* know these in adequate detail, and our logistic capability is insufficient to refine general knowledge to the extent we need for optimal conservation planning. 'The best we can do', however laudable and necessary, is often sadly uninformed. Recognition of this is an important step to improving our practical capability to manage insect species.

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