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Strategic planning for invertebrate species conservation - how effective is it?

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Abstract: Activities for invertebrate conservation range from single species programmes to those spanning habitats or landscapes, but at any scale are often largely isolated and not integrated effectively with other efforts. Problems of promoting invertebrate conservation and synergies by effective cooperation are discussed. The rationale of species-level conservation is outlined briefly, with suggestions of how some of the apparent limitations of this approach may be countered in ways that benefit a greater variety of invertebrate life. This essay is intended to promote debate on some of the complex issues involved, and implies the need for careful and well-considered integration of individual conservation tactics into enhanced strategies to increase the benefits from the very limited resources devoted to invertebrate conservation.

Keywords: Butterflies, conservation strategy, insects, management plans, species conservation, triage.

'You've got to accentuate the positive. Eliminate the negative. Latch on to the affirmative'. [Johnny Mercer/Harold Arlen]

INTRODUCTION

The broad term 'invertebrates' encompasses a great variety of hyperdiverse animal groups that are poorly documented, for many of which we have only very approximate ideas of their richness, and for which ecological and distributional information is commonly fragmentary to non-existent. Many invertebrates are believed to be under threat from anthropogenic changes, and both ethically and practically need conservation. They contrast dramatically with the more tractable vertebrate groups (mostly with comparatively few species and taxonomy well-understood) and some vascular plants, but have generally been treated by conservation planners in similar ways, focusing on single species management plans, and with agendas based largely on threat status evaluation by similar criteria to those applied to mammals and birds. This one-by-one species approach has severe limitations for invertebrates, not least because of large numbers of threatened species far exceeding resources available to conserve them. Likewise, their enormous taxonomic and ecological variety renders broader conservation prescriptions (beyond obvious generalities) difficult. Part of the perspective in discussing how—and if—better approaches are possible must be to assess our capability to plan and undertake practical conservation for invertebrates, and to assemble and improve conservation strategies to do this. Invertebrate conservation, at species or other level, is not a separate discipline from most vertebrate conservation, despite the vastly different scales of need that flow from enormous richness and ecological variety. Widespread unfamiliarity with

the organisms tends to foster it being treated as such.

'Strategic planning' in military terms is allied to the outcome of a campaign and implicitly demands integration of 'tactics', the lower category of planning and practical measures, for anticipated greater collective benefit than summing individual tactics alone. 'Tactics' equate to individual species plans or individual measures within these, and 'strategy' to any way in which these can be changed, amalgamated or replaced for wider benefit. A central theme is to consider whether invertebrates are disadvantaged, or may become so, in the wider conservation arena without such strategy. The scope of any conservation plan, together with its mission or purpose, may need to be considered very carefully. It should be defined objectively at the outset, together with provision for critical review before it is translated formally into policy and practice. At present, some purported strategies for invertebrate conservation are little more than 'wishlists' of ingredients and lack clear evidence of integration or complementarity of purpose or feasibility, although the need for this may be implicit. Most give priority to the importance of conserving the present scenarios or sites where the focal threatened species occur. These may include attempts to re-introduce populations to sites from which the organism has disappeared, or to augment small populations to increase their viability. With the widespread acceptance of climate change, needs for future evolution and dispersal potential are progressively being considered as constructively as possible. Long term strategies, to be assured well beyond the next one or two political terms, are a critical need, together with these incorporating dynamic 'adaptive management'. Climate change, for example, implies that sites well beyond the current species' range may be needed to replace present areas of occupancy that will no longer be suitable for habitation. Such considerations, however difficult to address, cannot be ignored and are urgent. Without such long-term perspective, many current management measures may be inadequate.

The stated 'visions' of conservation strategies tend to be formulated on the idealistic premise of 'zero extinctions'. Recent flurry of papers on this subject emphasises that, whilst we may indeed wish to heed this ethical ideal, some form of loss is largely inevitable in allocating resources when budgets are constrained (Botterill et al. 2008), with the impracticalities of completely supporting all deserving cases recognised by scientists, managers and politicians alike. Rational triage, however abhorrent, as a core strategy component has some benefit in enhancing credibility - because it demonstrates that priorities have indeed been set and lays out the grounds or principles for doing so. The major problem with setting priority in this way, most commonly selecting amongst an array of species eligible for support and needing conservation (designated by formal listing, or investigation of need) is simply that each species given priority is at the expense of others. The importance of the process therefore includes deciding what not to do. Triage in this sense is thus acceptance of the possibility of extinction of species excluded from attention (New 1991, 1993 for additional background). The grounds for this selection should ideally be transparent and agreed by wide consensus to avoid acrimony and promote cooperation by stakeholders. Thus, the Red-Listing of selected invertebrate taxa for conservation status priority promoted through the World Conservation Union includes several recent examples for which groups of specialists have agreed conservation status and needs during workshops convened expressly for that purpose. The ensuing reports have provided the first such authoritative accounts for particular taxonomic (e.g. Mediterranean dragonflies: Riservato et al. 2009) or ecological (European saproxylic beetles: Nieto & Alexander 2010) groups. Both these investigations, for example, indicated substantial numbers of threatened species. In addition to scientific knowledge of species' status and needs, 'image' can strongly influence choice of conservation targets and subsequent allocation of limited support resources. Many invertebrates have a less appealing public image than do many vertebrates: the 'cute and cuddly' syndrome is still influential, notwithstanding that many threatened vertebrates overtly exhibit neither of these qualities. Nevertheless, it is valuable to understand the grounds on which priorities have been selected amongst species, as possible constructive leads to wider strategy. It is important to acknowledge also that defeatism from the implications of triage is not universal: Parr et al. (2009) cleave to the ideal that 'we just might save everything', and that we should indeed aim for zero extinctions.

A somewhat different emphasis was presented in the recent 'European Strategy for Conservation of

Invertebrates' (Haslett 2007), namely to recognise the importance of invertebrates, rather than demanding that all be conserved. The Strategy's vision is 'A world in which invertebrate animals are valued and conserved, in parallel with all other groups of organisms, now and in the future'. The seven main objectives emphasise recognition and integration of needs and efforts to conserve invertebrates. One objective (no. 6) is echoed widely elsewhere: '… inclusion of a fully representative variety of invertebrate species on conservation and environmental management decisions..'. The process of triage or other selection to obtain 'fully representative variety' demands rather different priority than triage based purely on level of threat, as tends to flow in many places from IUCN or other categorisation, irrespective of what the invertebrate is or of its ecological role and distribution.

There are obvious problems in this 'omission by necessity' in emphasising species-level conservation whilst ignoring other, wider, approaches, and three broad packages of strategy options are available;

1. To improve individual species plans to render them increasingly credible, practicable and effective.

2. To expand plans based initially on individual species to promote wider benefits – such as providing for several related species or changing focus for wider habitat considerations.

3. To adopt the commonly-made suggestion of replacing most individual species plans with broader approaches to emphasise landscape and community conservation, so assuring contexts in which the species can survive.

These are not mutually exclusive.

Many species management plans for invertebrates have been largely ad hoc developments, and many have been produced in isolation from (or with little consideration for) other organisms, even those on the same sites or dependent on the same biotopes. It is pertinent to consider the drivers for developing these plans, and the reasons for their production. These are not restricted to invertebrate plans, of course, but may at times have greater importance for them when combined priority is needed. The three major drivers are (1) legislative obligation, (2) political appeasement, and (3) practical conservation. Each may suffer considerable delay in development, and it is common for the formal obligations for plans that commonly flow from legislative recognition of taxa as threatened to take far longer to produce than promised under a given legislation. However, many plans under the first two drivers above are superficial and couched in rather general terms rather than containing well-planned SMART objectives and actions. Further, most of those plans are not fully translated into practice, but remain as 'ticked off' on a list of formal obligations. Many conservation plans for invertebrates are necessarily proposed or prepared initially by people who are not invertebrate zoologists. If indeed zoologists, many agency personnel are versed predominantly in vertebrate biology and (1) are outside the area of their primary interest or expertise when dealing with invertebrates and so (2) may give them low priority in relation to dealing with organisms with which they have greater confidence and experience, and (3) may not appraise and criticize the outcomes adequately. Without initial effective peer-review and revision, a plan may be overly bland - and, perhaps, far more tentative than if prepared by a relevant specialist in the organisms involved. A major need is to increase invertebrate expertise in the variety of agencies involved in such documentation, and to move progressively toward scientifically rigorous and adequately resourced conservation plans, rather than being content with superficial alternatives. Nevertheless, political awareness of need for invertebrate conservation is important, and there may thus be a very constructive role for plans in categories 1 and 2 above. But they may not always achieve the major aim of practical conservation.

The relevant point of contrast is that many vertebrates already have high public profiles, and are widely accepted politically as 'worthy'. So-called 'vertebrate chauvinism' remains potent in developing conservation policy, and greater levels of interest and knowledge facilitate production of progressively realistic and credible conservation plans.

A second contrast in many cases is that of scale of management need. As one common example, small sites which would be dismissed as inadequate for conservation by many vertebrate biologists, and sacrificed, have immense importance for some butterflies and others that can sustain populations on areas of a hectare or less under suitable conditions. Many invertebrates are, or appear to be, point or narrow range endemic species. In management terms, this also involves ecological specialisation - many vertebrate

foci for conservation are, by comparison with many invertebrates, both geographically and ecologically more widespread: not only are we likely to know much more about their population size and dynamics, but also have a reasonably clear picture of the major threats to them. Almost by default, the resource needs (both consumables and utilities, sensu Dennis et al. 2006) of ecologically specialised insects are more restricted and restricting to the species involved. Following Hanski's (2005) apposite simile of insect habitats forming a nested hierarchy of scales, and likened to matrioscka dolls, most habitats of threatened insects (many of which have very narrow ecological amplitude, in additional to restricted distributions) equate firmly to 'small dolls', so that fine scale refined management may commonly be needed. Equivalent fine detail, of course, occurs also for many vertebrates and for any species this level of management becomes both difficult to define and expensive to prosecute. In an environment in which the limiting costs of conservation are a primary consideration in determining priority, less subtle steps (such as site reservation alone) may be deemed sufficient. From another viewpoint, it is often assumed that areas reserved for particular large or iconic vertebrates (such as forest primates) will effectively also protect everything else that lives there - so that the focal vertebrate is presumed to be an effective umbrella species. This presumption is dangerous and must not be accepted uncritically; simply that a butterfly or snail lives at present in a high ranked protected area such as a National Park that also harbours a threatened parrot, rodent, or ungulate does not secure it in perpetuity. Even in Britain, many population losses of butterflies in such areas have occurred but, conversely, a preserved area may give a secure base for the management needed to foster conservation. For Australian butterflies, Sands & New (2003) urged surveys of protected areas to determine incidence of designated threatened species, and so save the massive costs of private land purchase or assuring security of tenure elsewhere, should already protected populations exist in areas in which management could be undertaken. A protected site is the major need as focus for more detailed conservation, but is no more than that vital first step - detailed management, such as to assure early successional stages on which many invertebrates depend, must be based on individual circumstances, and at this level, some site-specific management is largely inevitable to sustain particular species or wider representative diversity. Almost invariably, primary research will be needed to focus management effectively. Emphasis on habitats (rather than the species alone) tends to shift the focus of strategies along the gradient 'species - community -habitat - ecosystem - landscape', in the expectation that broader scales will prove more cost-effective: for most invertebrates it remains to be proved that this approach is also more conservation-effective.

Indeed, for many invertebrates, knowledge is insufficient to formulate any realistic conservation plan extending beyond bland generalities without insights from a strong research component. In many groups, the only people who are familiar with the species in the field are those involved in bringing them to conservation attention - so that even independent peer review of nominations for protection or funding may be difficult to arrange. There is understandable temptation to extrapolate from knowledge of any related species of concern or in the same arena, but this can rarely (if ever) replace information on the focal species. Focus on 'better known' groups is common - both knowledge and image impediments may be at least partially overcome for many butterflies, for example, simply because many butterfly species conservation plans have been made and carried into practice to varying extents. In Britain, an initial tranche of 25 butterfly species action plans was made, as working documents, by Butterfly Conservation in 1995. The variety included helps indicate general features applicable elsewhere as well as measures that can be carried across plans for different species. People may thus feel more comfortable working with 'another butterfly' than with some less familiar and poorly known animal. By parallel, the large number of vertebrate species plans helps generate confidence in producing others; for many, the research component needed initially may be relatively small, because of the large amount of attention vertebrates have received already.

However, few groups of invertebrates can be treated in the same way as butterflies, or birds or mammals - some groups of beetles, moths, and terrestrial snails are, perhaps, the main contenders. In contrast, many groups rarely, if ever, appear on conservation agendas - for many (see Wells et al. 1983 on Tardigrada) knowledge is patently inadequate to assess the status

of any species reliably, and interest in doing so scarcely exists. Substantial taxonomic lacunae persist in the invertebrate conservation portfolio!

Haslett (1998) in considering priorities for augmenting the list of insects to be included under the Bern Convention recognised, as have many other commentators, that there are simply too many deserving candidates. Whatever we elect to include, we are 'spoiled for choice', principles for selection may differ with different taxonomic groups (depending on level of interest and knowledge), and additional criteria such as habitat factors, global centres of endemism, hotspots of richness, and functional roles might all contribute to selection. Extending the range of criteria in this way helps draw attention to the invertebrate variety and the importance of the biotopes in which they live. Haslett thus noted cave systems, running waters, and saproxylic environments as some which were under-represented by invertebrate listings in Europe, and supporting functionally important invertebrates without which those systems could not persist.

Contrast this approach with adding yet more butterflies characteristic of open woodland, heathland, or subclimax vegetation systems, for which other priority species already represent the value and importance of those biotopes. With some further attention to habitat health - as a stated priority in almost all conservation plans - relatively small augmentations have potential to change single species plans to covering an array of co-occurring species, each treated as an individual focus. The major need here may be simply to broaden perspective to emphasise the importance of the community as the context for any focal species to thrive, and that treatment of individual species can have wider effects. This goes beyond the usual tacit and more anonymous umbrella approach because it combines separate management needs of carefully selected species for wider collective benefit. It moves toward a 'habitat directive' approach of incorporating broader values.

In reality, any and every list of invertebrate species of conservation concern, however these are selected or given priority, will be both (1) too long for all the species to be dealt with individually and (2) too short to be ecologically or taxonomically even reasonably representative of those needing that attention (New 2009 for discussion). Increasingly, selection transcends both taxonomic and political boundaries and draws on ecological and distributional knowledge to seek principles as the bases for strategies to achieve this effectively. Political boundaries, such as contiguous countries in Europe or states in North America or Australia, are each subject to geographically restricted legislations, so that policy at the higher national or regional level is needed to harmonise and facilitate conservation beyond those boundaries. A global review of the various national and regional legislative provisions for invertebrate conservation, much as Collins (1987) initiated for Europe, together with critical appraisal of their achievements, may give valuable clues to future needs.

DO WE NEED MORE BUTTERFLY PLANS?

Formation of the organisation Butterfly Conservation Europe, coupled with the recent European Butterflies Red Data Book (Van Swaay & Warren 1999) and a treatise on priority sites for butterflies in Europe (Van Swaay & Warren 2003), has emphasised the magnitude of conservation effort needed even for this best-documented and most popular invertebrate group in the world's best-known regional fauna. It has also revealed effectively the logistic problems of dealing with these needs comprehensively, and with adequate coordination.

Regional endemism is strong, with 19 threatened butterfly species restricted to Europe accompanying a further 52 species threatened in Europe but found also beyond Europe. The 19 threatened endemics could justifiably be given priority, but the markedly lower conservation interest for some of the others outside Europe throws the major conservation burden and responsibility onto securing populations within Europe, so that their threatened status within Europe must be taken seriously. Whatever actions ensue, the grounds for conservation need are here clear and soundly investigated. The 'SPEC' system applied to the European butterflies, following its development for birds, combines considerations of threat and geographical range (Table 1). Adding the SPECs for political units helps to reveal a geographical pattern of relative need. It does not take into account *per se* the measures needed, and at its most basic level has simply indicated the sobering scale of needs (and supporting

Table 1. Concept of 'Species of European Conservation Concern' (SPECs) in designating conservation importance, based on (1) global conservation status, (2) European threat status and (3) proportion of world range in Europe (From Van Swaay et al. 2009) ('Threatened' is one of Critically Endangered, Endangered or Vulnerable)

Category		Specification
SPEC 1		Of global concern because restricted to Europe and considered globally threatened.
SPEC 2		Global distribution concentrated in Europe, and considered threatened in Europe.
SPEC 3		Global distribution not concentrated in Europe, but considered threatened in Europe.
SPEC 4	4a	Global distribution restricted to Europe but not considered threatened either globally or in Europe.
	4b	Global distribution concentrated in Europe, but not considered threatened either globally or in Europe.

resources) that emerge if we remain committed to single species focus alone.

However, from wider considerations of the ecology of European butterflies, several general principles of wide importance emerge (Settele et al. 2009: Table 2). These emphasise the fundamental roles of habitat conservation, including supply of critical resources, the needs to foster conservation in anthropogenic areas - particularly agroecosystems and urban areas - and to increase education and support for this, with care not to overgeneralise in any context. Some of these are important pointers toward wider strategy, involving both landscapes and politicoscapes. Agricultural ecosystems present multiple opportunities for both, such as mosaic management to incorporate conservation needs, together with offsets and trading policy modifications (New 2005; Samways 2007). Achieving any of this necessitates goodwill and demonstration of the benefits, together with inducements for change (such as offset rewards, direct financial compensations, evidence of tangible uses such as pest suppression by conservation biological control, and so on).

Table 2. Factors that may help guide conservation of butterflies, based on the European fauna (after Settele et al. 2009).

Butterflies in modern landscapes cannot survive without active management.
Traditional management practices have been (and still are) the driving force for the evolution of plant and animal communities of European ecosystems.
A recurrent pattern of dependence on early successional stages is evident.
Continuation of natural disturbance (exemplified by landslides, avalanches, outbreaks of defoliating insects, animal grazing) is critical.
Many remaining sites are too small for sustaining populations of specialised species, so increased connectivity may be critical for long-term survival.
When remnant habitats remain small and isolated (as for many species) management must adopt a mosaic (patchy) approach.
Where large habitat areas occur, management should also be mosaic, but to create networks of different land use regimes and intensities.
Indirect effects on sites important, in addition to direct alterations.
Agri-environment schemes are vital and should target resources needed by wildlife.
Support programmes for these need to increase consideration of needs of biodiversity, rather than just expediency.
Urban areas are also a primary focus for the future.
Avoid unified prescriptions.

Multiple examples within the same taxonomic group, such as the European butterflies, (1) help to demonstrate the real scale of need for conservation action; (2) lead toward key general ecological and management themes; (3) increase the difficulties of selection or triage; and (4) lead to increased taxonomic imbalance in assuring invertebrate representation on conservation agendas. Working with 'what we know' or 'what we like' is both appealing and pragmatic, but may not be enough. It is necessary to capitalize on such 'well-known' groups as effectively as possible to promote conservation awareness, and - in that example - using our knowledge of European butterflies as an educational avenue may provide greater collective benefits than insisting on a broader taxonomic array of invertebrates on any local directory - especially when we know virtually nothing about those additional taxa. One major lesson for strategy development results from the disappearance of many butterfly populations from nature reserves in Britain, despite early confidence that they could thrive indefinitely on small (10–100 ha) areas. As noted above, securing a site is not alone sufficient, and the key to preventing loss is fine-scale, information-based management.

Butterflies have massive importance for conservation policy, likely to persist, as a flagship group of terrestrial insects, with the plight and treatment of European species serving as models for much of the rest of the world. As a 'stand-alone' group, they have potency, with potential to compile suites of specific umbrellas for a variety of ecosystems and places without need to invoke less sensitive vertebrates in this role. Few scientists, I think, would disagree that some priority might be accorded within invertebrates to those that give us sound and subtle information on environmental changes and condition (New 1993) - or

Table 3. Some criteria that may be useful to select invertebrate groups as priorities in conservation, as 'tools' in wider environmental assessment (variously as indicators, flagships, umbrella groups and keystones) (after New 1993).

Taxonomy well-known (species recognisable and namable).
High diversity (collective responses to environmental changes).
Geographically widespread (collective benefits and experience across similar taxa in various places).
Abundant/dominant (sufficiently accessible for realistic information).
Accessible to standard sampling (can detect responses).
Ecology understood (can interpret responses).
Occupy key ecological roles (functionally definable, justify use pragmatically)
Habitat specific (sufficiently circumscribed for responses to be relatively specific).
Respond to changes in environment (increased values as indicators or monitoring tools).
Engender public sympathy (advocacy, overcome perception barrier by demonstrated values).

that are keystone species, effective flagship or umbrella species or simply have political and educational value from 'rarity' alone. The categories of relative factors (New 1993: Table 3) may augment the generalities suggested above for European butterflies. Despite cautions (see Simberloff 1998) I do not believe we can afford to abandon some focus on individual species in developing invertebrate conservation strategies, but in many contexts the principles of triage - whether based on taxonomy, habitat, ecological role, extent of threat, or other, may need to be subsumed progressively in favour of wider issues. Knowledge and understanding of distributions, biology and systematics will remain highly incomplete, and invertebrate conservationists cannot be persistent apologists for this. An 'impediment' can so easily be also an 'opportunity' - but strategies must heed major practical issues whilst acknowledging the importance of those minutiae in a (non-realistic) ideal world. Focusing on our ignorance, rather than what we do know, weakens our advocacy considerably. Issues include not preparing superficial individualised conservation plans for each of the vast numbers of threatened species that we do not understand adequately - these are rarely competitive for the limited funding or other support available, and simply acknowledging their threat status formally (such as on a widely available advisory list) may accord the same notoriety. Wider plans for either better-known taxonomic groups (e.g. carabids or weta in New Zealand, *Maculinea* butterflies in Europe, selected *Harpalus* ground beetles in Britain), or ecological arrays (e.g. saproxylic insects) give initial wider focus and reveal possible generalities or common features across constituent species, as well as signaling their importance. Agreement on a suite of focal groups for such treatments, with a well-defined common approach, to include practical milestones and monitoring criteria against SMART objectives, would be invaluable. The 'Globenet initiative' (Niemela et al. 2000) was planned to document the urban-rural transitions of carabid beetle assemblages in different parts of the world, for example, but parallels have not proliferated. Standard approaches are difficult to promote - standardised sampling protocols have been proposed for ants (Agosti et al. 2001), but lack of widespread common approaches to evaluation render inter-site and international comparisons of richness and numerical trends almost impossible.

For most invertebrates, we simply do not know specifically whether they have ecological 'importance', and what the consequences of their demise might be. Collectively, these are the 'meek inheritors' (New 2000), often taxonomically orphaned and ecologically neglected, and to which we pay token ethical acknowledgement whilst also being largely helpless to conserve them other than by generalised biotope security as an anticipated umbrella effect. This is usually without assurance that any such areas can be managed for successional maintenance or be resilient to climate change. Most of these species cannot be promoted individually or effectively on ecological importance, even though this is often considerable. Many soil invertebrates play ecological roles that are significant and pivotal in sustaining the ecosystems in which they participate and, as Wall et al. (2001) put it 'We do know that soil and sediment communities perform functions that are critical for the future of the ecosystems as a whole, although the role of biodiversity in the processes is poorly understood' (p. 114), coupled with 'The public is generally unaware of the essential ecosystem services provided by subsurface organisms' (p. 115). Similar comments could be made for many other aspects of invertebrate ecology, encompassing many taxonomic groups.

Many commentators on development of conservation biology over the last few decades (in part summarised in Soulé & Orians 2001) have repeatedly noted a number of themes that are essential to consider - some born of need, others more of frustration and that would be more tangential to core conservation practice. Janzen's (1997) essay on what conservation biologists

do not need to know helps to emphasise the need for clear focus. Precise documentation of biodiversity may indeed be distractive, for example. The embracing themes listed by Soulé & Orians, together with reviewing progress since the earlier account by Soulé & Kohm (1989), reveal the many persistent gaps in coverage. Progress might be demonstrated more effectively through smaller scale operations, so that the individual tactics of a concerted strategy have massive political value once demonstrated successful.

COMPLEMENTARITY

Many sites, across a wide array of ecosystems, have been signaled as having especial conservation importance. These are either general hotspots (Myers et al. 2002), or much more finely delimited areas of value for conservation of particular groups of organisms. They thereby parallel the Butterfly Priority Sites for Europe, but establish a framework of readily acknowledged importance - for birds in particular. Ramsar wetlands, for example, are distributed very widely, and many have considerable importance also for aquatic invertebrates. Moves to include dragonfly conservation (Moore 1997) within the aegis of these reserves are perhaps a priority in helping to overcome the additional logistic restrictions that more obviously independent moves would create. Another example is Birdlife International's global network of 'Important Bird Areas' (IBAs), designated as sites of critical conservation value or that support key species. Their advantages are that, at least for birds, sites can be managed as single units, but combined with limited species-specific conservation where needed. They vary greatly in size, and can collectively cover all relevant ecosystems. Australia's 314 recently designated IBAs, for example, include examples of most biotopes across the country, together with important island sites, all initiated under a strong support network (Birds Australia) likely to assure continuing interest. More broadly, the UK 'Sites of Special Scientific Interest' incorporate individual and occasionally broader invertebrate values. For any of these categories, additional conservation values, including those of notable invertebrate species or communities, might enhance conservation interest.

However, if we seek to incorporate invertebrate conservation into such established initiatives for birds or other organisms, we need to assess carefully what compromises and compatibilities are really possible, particularly in relation to need for any different scales of management. Insects pose different conservation problems to birds in Europe, for example (Thomas 1995), with their needs affecting management. Climate may influence insect distributions far more than those of birds, but a major contrast is that many insects with ecologically specialised needs are often associated with ephemeral successional stages - so that a small patch of habitat/biotope at present suitable may remain so for no more than a decade or so, and often considerably less. Further, restricted dispersal capability may prevent many insects colonising nearby habitat patches as they become suitable, even when these are only a few hundred metres away. In the past, it seems that sensitivity to temperature by many insects may not have been acknowledged sufficiently in conservation planning. Many insects in Britain now depend on traditional farming or forestry practices to maintain suitable conditions, simply because these practices may regenerate early succession at intervals of only a few years. Whilst Thomas' inferences were largely from studies on butterflies, Moore (1997) noted the importance for dragonflies of habitats outside formal protected areas, and the importance of landscape features is now a central plank in insect conservation advocacy (Samways 2007). Offsets and direct financial subsidies or incentives as tactics to gain sympathetic management of private lands are becoming varied.

'Value-adding' for wider conservation benefit takes many forms, but it is still rare for invertebrate conservation to drive major conservation endeavours and thereby become the major benefactors for communities that also include sensitive vertebrate species. In south eastern Australia, the endangered Golden Sun-moth (*Synemon plana*, Castniidae) is one of a trio of flagship species viewed as critical foci for threatened native grasslands - the three are publicised as 'a legless lizard, an earless dragon, and a mouthless moth' but *Synemon* is accorded at least the same significance as the two reptiles. Perhaps only the most notable invertebrates can be useful in such roles, and in situations where novelty value also persists, in which they can be garnered for political advantage. The world's largest butterfly (Queen

Alexandra's Birdwing, *Ornithoptera alexandrae*) is a notable example, for highly vulnerable primary forest communities in Papua New Guinea (New 2007, 2011, for background). The ubiquity of invertebrates gives them considerable importance in conservation of particularly restricted or vulnerable habitats - as well as forests and grasslands as above, partulid snails on Pacific islands, dragonflies in wetlands, and a variety of arthropods in caves are simply further examples from an endless possible array.

TARGETS AND TOOLS?

The dual foci of invertebrate conservation based on conservation of individual focal taxa (targets), however these are selected, and wider values in ecological assessment or other human terms (tools) will assuredly continue. The balance between these will also continue to be flexible and reflect local needs and complexity. Any single strategy developed cannot therefore be universal or comprehensive, and this reality - even if it appears defeatist - must be accepted as a practical working guide. A number of fields of practical conservation interest that may help progress and integration can be specified, but the major themes of increased education, awareness of need, and appreciation of ecological importance as benefits that cannot be costed fully in dollars, are more difficult to convey. They are the foundation of capitalising on whatever biological knowledge is available but, without that advocacy and acceptance, any science-based strategy is likely to fail. Not least, the needs to transcend political boundaries, to harmonise human needs for land use and resources with adequate conservation, and secure a full range of representative habitats with provision for future changes for biodiversity conservation include both pragmatic compromise and ethical integrity, and many such decisions are deficient without inclusion of invertebrates.

It is difficult to decide whether our capability for such wide-ranging strategy design has really improved over recent decades. In common with much other conservation practice (Soulé & Orians 2001), progress has been made, but central problems continue to dominate. In part, this reflects that the embracing themes are indeed broad, so that tangible progress may be assessed more easily from smaller scale approaches - for which invertebrates afford many examples of ecological specialisation, endemism, distribution (etc.) which draw attention to this need for detail to be included within wider strategic moves. A successful strategy must be capable of implementation and assessment, rather than simply remaining as a design document based on unrealistic demands. Initial considerations include (1) existing plans for any focal species, biotope or site, or similar ones from which information can be derived, and (2) how to integrate or augment these for wider benefits, once these have been defined. The full range of interested stakeholders (community, authority, science) should be involved from the initial stages, and continue to be represented on the management team - many plans have in the past failed through not heeding the interests of important community or other constituency groups whose interests are affected by the process. Many strategies initially have narrow focus, because they are stimulated by local issues, but it is pertinent to consider the widest relevant geographical scope from the outset, and how any local strategy may be broadened in effects. The MacMan project, for the five species of large blue butterflies (*Maculinea*) in Europe, integrated many local conservation interests into a continent-wide approach. Almost a hundred papers across its major themes presented at a recent symposium (Settele et al. 2005) demonstrated the advances and consolidation of knowledge and practice that can occur from such breadth of focus.

POINTERS TO STRATEGY

Ad hoc conservation plans may prove excellent investments in many cases but alone can never fill the wider needs for invertebrate conservation. Successes gained are important demonstrations of what can be done, and vital for effective advocacy as case histories for education. Few, however, have been costed adequately (or, at least, have furnished such details for public scrutiny), and almost all have a strong component of volunteer support as a key contributor to success. Further review of species management plans may further aid detection of the common themes needed, and how accountability may differ under different governing authorities (New 2009).

The scope of the exercise must be clear from the start, with clear definition of the objectives and synopses of the actions proposed, preferably in SMART terms (New 2009). A clear sequential process exists for this, whatever scale is anticipated. Either for an individual plan or a wider strategy, careful planning at the outset may pay dividends. Among these, an objective appraisal of what may be gained, and also of what may be lost, through a wider perspective is wise, together with a frank appraisal of the influences of the compromises that may be needed. For example, evaluation of threats for a snail or beetle may be very different in scale than to a bird or mammal in the same area, and ameliorative micromosaic management may become more difficult to pursue. 'Smart decision making', as discussed by Possingham et al. (2001), is critical but - as they pointed out - few protocols exist for answering even very basic questions in conservation management, and perhaps nowhere less so than for invertebrates. Those protocols that have been suggested may be based on single cases rather than on a replicated suite, and on results whose causes are not fully understood. With insect translocations, for example, we often do not know why any particular exercise succeeds or fails, often simply because the outcome is not monitored in sufficient detail (Oates & Warren 1990).

Despite increasing awareness of needs for invertebrate conservation, and substantial attempts to 'accentuate the positive and eliminate the negative', many of the basic points that have arisen have yet to become established firmly or consistently on political agendas. Yen & Butcher (1997) noted the perception impediments for invertebrates that arise from (1) small size, equated commonly with insignificance; (2) high diversity and abundance, associated with difficulty of study and with lack of vulnerability; (3) adverse publicity associated with pests, nuisances and general antagonists to human interests; (4) entomophobia; (5) their being 'a low form of life'; and (6) innate reluctance to understand them. The last two points, among those discussed by Kellert (1993) are commonly overlooked but important influences and, as Yen & Butcher emphasised, many of these impediments are encountered by people in early childhood; they are amongst the most important 'negatives' to be eliminated. Conservation measures and advocacy for the Elephant Dung Beetle (*Circellium bacchus*) in South Africa have helped to change the perspective for elephants emphasised by Poole & Thomsen (1989), and similar examples are becoming more frequent.

A successful strategy is one that works! Knowledge and experience are 'positives', but it is all-too-easy to get distracted by research that is of fundamental scientific interest and value but may not directly focus on conservation. Many conservation biologists wish primarily to 'do science', and can run risks of losing touch with managers whose priorities are founded in a different perspective. A strategy cannot be based on ex cathedra statements: invertebrate conservation biologists and other scientists are not simply talking to their peers, but to the global constituency of people whose interest and livelihood are affected by management decisions. Strategies should ideally be based in truly cooperative endeavour toward realistic agreed objectives, in a cultural environment in which invertebrates do not have to be rescued from political and conservation oblivion.

Perhaps the biggest question to address here is whether invertebrate species-level conservation has serious place in future conservation strategy. With the very real and continuing scientific and logistic difficulties, would invertebrates indeed be served better as passengers under any wider umbrella endeavours to which greater support could then be given? If this approach were adopted, could benefits to invertebrates even be measured? Proponents of not focusing specifically on invertebrates are commonly those who dismiss them as 'too difficult' or 'too numerous'; their supporters tend to emphasise the subtle differences in biology and resource uses flowing from ecological and taxonomic variety, some citing values as 'indicators' in various contexts. Both recognise the intrinsic difficulties of advocacy and garnering effective support on any wide basis, and the ethical dilemmas that arise from simply ignoring such major components of Earth's biodiversity. I would urge that we continue to benefit from the understanding of individual species conservation programmes spanning a substantial variety of invertebrate life forms and life styles, to facilitate their participation in wider conservation agendas, and to accept that an important component of our job is to make such strategy work.

Careful consideration of the issues noted in this essay, and debate over their worth and feasibility, may contribute to this end.

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