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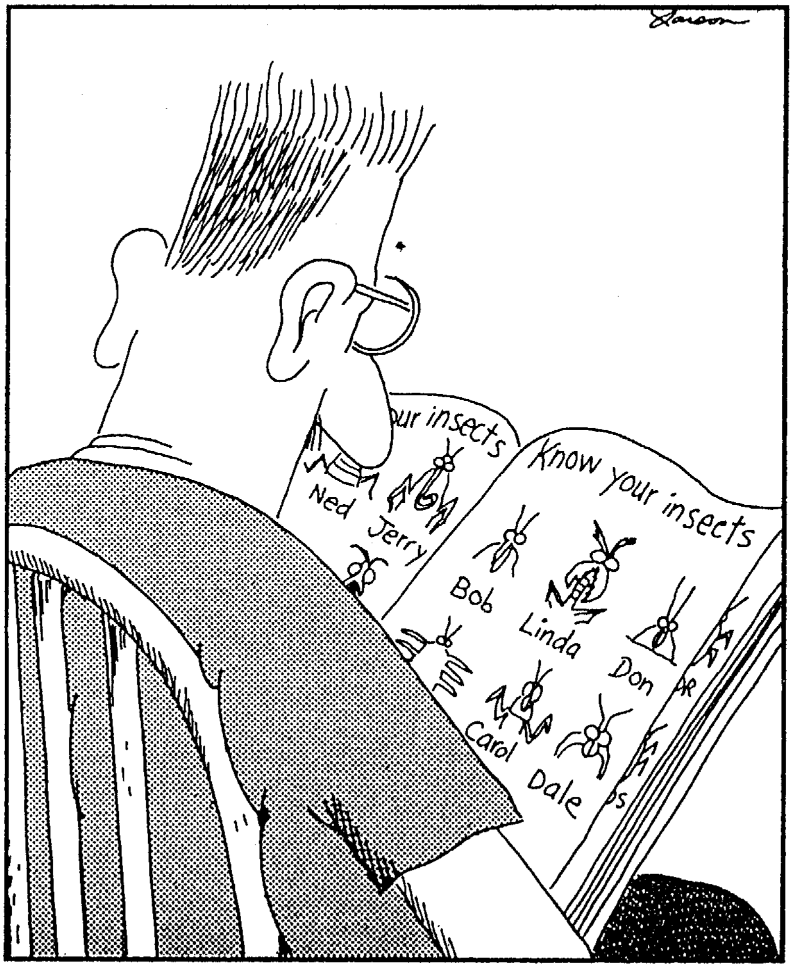

THREATENED TERRESTRIAL INSECTS: A WORKSHOP TO ADVANCE CONSERVATION

Mary Cresswell and Dick Veitch

Department of Conservation
Te Papa Atawhai

THREATENED SPECIES
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A WORKSHOP TO ADVANCE CONSERVATION

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ERRATUM

The notes on `Rearing Endangered Species' (pp. 50-51) were written by Graeme Ramsay and presented by John Dugdale; they were not written by John Dugdale.

Key words: terrestrial invertebrates, ecological management, monitoring, research priorities

Cover picture from *The Far Side Gallery 3,* by Gary Larson; Warner Books, 1990; reprinted with permission.

Note: The presentations included in this occasional publication have been handled as notes only and have included only material available as at August 1994. There has been very minimal editing; no attempt has been made to review content, fill out or supply references, or otherwise handle editorially. Publication here does not in any way preclude submission of any of these papers to another scientific publication. Material was collected by C.R. Veitch and typeset by Mary Cresswell.

CONTENTS

INTRODUCTION

In New Zealand, there is a long history of research on invertebrates. In the last hundred years, an impressive array of descriptive work on insects has been presented in the published literature. Unfortunately, invertebrates have not received a similar level attention, from either the public or from conservation managers.

The sheer number of invertebrate species is not yet fully recognised, nor do we know the key part these animals play in driving and supporting ecosystems, as indicators of ecosystem health, or as 'management' indicators, demonstrating the effectiveness of conservation management undertaken.

The workshop represented by the notes in this publication was held at the University of Canterbury from 12 to 14 May, 1993, under the sponsorship of the Department of Conservation.

The workshop goal was to improve and promote, through detailed discussion between scientists and managers, conservation research and management of threatened terrestrial insects. The stated objectives were (1) to review the effectiveness of current management activities and the value of research as a management tool, (2) to propose standards for the long-term monitoring of threatened terrestrial insects, (3) to discuss priorities for conservation management, monitoring and research related to threatened terrestrial insects and their habitats, and (4) to consider the opportunities for raising the awareness for insect conservation.

These proceedings do not represent a comprehensive record of all that was presented at the workshop. In line with the informal and consultative style of the workshop, as much as was obtainable of the addresses, discussions and recommendations have been summarised and compiled with minimal subsequent review or refinement. As such, I hope they serve a purpose in reminding people of the issues raised and of recommended actions.

While the delay in producing these proceedings is regrettable, I found it interesting to re-read this material and observe the sequential progress which has been and is being made in some of the issues raised, such as the development of invertebrate monitoring programmes associated with ecological restoration projects, and the achievement and implementation of insect recovery plans.

I am also heartened by the dialogue which is developing between a growing number of people with expertise and enthusiasm to contribute to insect conservation. I believe this augurs well for further significant progress being made in the future.

ALAN SAUNDERS
Manager, Threatened Species Unit

THREATENED INSECT CONSERVATION: THE HISTORICAL PERSPECTIVE

GREG SHERLEY
Department of Conservation
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This paper comprises short bullet points - buckshot, as it were - aimed at the work conducted in the last decade on New Zealand insects. Not only it is important to look at present work in context, it is also worth having such information available as a basis for dicussion of current work and trends.

A definition: **Conservation of insects is advocacy, research on and management of insects (as single species or communities) and their habitat(s).**

Some conservation work has been dedicated to insects as the reason for its implementation, but many studies and much ecological management has been done with beneficial spin-offs for the conservation of insects, even though this was not the primary aim of the studies.

Most conservation work on insects is unpublished, so most of what I have gathered together is drawn from my own experience. The comments would of course take a different form if supplemented by others; here, the comments are intended only as a starting point and - to stay with my original image - shots scattered across a field too broad to cover adequately in this workshop.

For convenience, I have often classified insect conservation work by the author who has been primarily responsible for the work. While an 'historical perspective' implies to me a significant passage of time, most conservation work targeted at insects has occurred in the last 5-10 years. Hence the bulk of this paper concerns that period. For the purposes of this talk *management* includes buying land.

ADVOCACY: EVENTS, PEOPLE, AND TOPICS

Wildlife Amendment Act 1980

Peter Johns - advocacy work for invertebrates generally through National Park and Conservation Boards.

Graeme Ramsay - advocacy work for threatened insect species through expert submission to Government policy makers, IUCN.

Mike Meads - advocacy of weta conservation with publications on taxonomy and general readership.

New Zealand Zoos - especially Wellington Zoo: e.g. wets week.

NZ Department of Conservation - Conservation Week: Tiny Tyrants and Mighty Midgets, Mahoenui weta

Save our Snails - *Dorcus* poster: "Beetles are Beautiful"

Television - documentaries on invertebrates (e.g. weta) in preparation

MANAGEMENT: EVENTS, PEOPLE AND TOPICS

Surveys - NZ Arthropod Survey (DSIR and subsequent organisations) - results fed into reserve acquisition proposals over the years.
New Zealand Forest Service and allied agencies' forest insect surveys

Cromwell Chafer Beetle Reserve - begun by Department of Lands and Survey.

Reserve fenced on the South Wellington coast to protect habitat important for the spear grass weevil *(Lyperobius huttoni).*

Ad hoc surveys by individuals for specific groups - e.g. Ian Townsend's searches for endemic carabids in the Marlborough Sounds.

Mike Meads - successful translocation of *Deinacrida rugosa* from Mana Island to Maud Island; captive breeding of various species for translocation - e.g. Middle Island tusked wets, Mahoenui giant wets; survey of giant weta throughout the country to establish their conservation status; translocation of knobbed weevil *(Hadramphus stilbocarpae)* and flax weevils *(Anagotus fairburni)* in Fiordland.

Mahoenui giant weta *(Deinacrida* n. sp.) - two founder populations established.

Stag beetles - survey to establish conservation status of presumed rare species.

RESEARCH: EVENTS, PEOPLE, AND TOPICS

G.V. Hudson noted in his pioneering writing concerns for the conservation of various insect fauna.

Though not specifically targeted at conservation, taxonomic research carried out by Universities and Entomology Division DSIR (and subsequent CRTs) has greatly facilitated conservation work.

Biogeography - various academics have studied the patterns of distribution of taxa and their phylogenies in space and time and, in turn, how these relate to world-wide patterns.

Ramsay, Graeme (1955) MSc thesis forVictoria University, on the life history of *Deinacrida rugosa.*

Bull, R M. (1967) MSc thesis for Victoria University, on the life history of *Lyperobius huttoni* (Pascal 1876) on the South Wellington coast.

MSc on Cromwell Chafer *(Prodontria lewisi)* - habitat use, predation and distribution.

Tony Beauchamp - research on the distribution and habitat requirements of *L. huttoni* on the south Wellington coast 1988-1991; research on habitat use and recovery of *Deinacrida rugosa* on Mana Island following the mouse eradication programme 1989-1991.

Mary McIntyre - habitat preferences and dispersal behaviour of *D. rugosa* on Mana Island; habitat use, dispersal and ecology of Middle Island tusked weta.

Brent Emerson - taxonomy and conservation status of *Prodontria* species in Otago.

Banks Peninsula tree wets *Hemideina ricta* - MSc study on their habitat use and general ecology.

Mahoenui giant wets *(Deinacrida* n.sp.) - one study by Sherley and Hayes on life history and habitat use; two MSc studies - one on dispersal behaviour and survival, and one on the effects of feral goats on modifying their habitat.

High country grasshoppers - *Brachaspis robustus :* survey work, studies on its ecology (Graeme White). *Sigaus minutus -* some survey work.

Hutchinson - relative abundance of insect fauna in different seral stages of forest; effects of 1080 poison application on non-target (insect) fauna; other allied community research.

Landcare Research NZ Ltd: effects of 1080 poisoning of possums on non-target invertebrate communities - especially insects; effects of possum browse on the invertebrate communities associated with pohutukawa.

Paddy Walsh - relative effects of different degrees of milling practices on invertebrate communities (mainly Insecta).

PNA survey - Brian Patrick and others survey of invertebrates in some of the surveys conducted by the Department of Conservation.

Kevin Collier - status, distribution and conservation of freshwater invertebrates in New Zealand.

Blue duck - some spin-off knowledge of aquatic fauna communities in blue duck streams.

Genetic studies (in progress) - *Deinacrida connectens* complex, *Hemedeina* - North Island species, *Hemideina maori.*

Spiders - *Spelungula cavernicola,* Nelson limestone cave spiders. Caves managed to minimise visitor impact. MSc project on ecology with conservation emphasis.

OTHER COMMENTS

Almost no conservation work has been aimed specifically at aquatic insects.

Most conservation work targeted at insects has been research; very little has been aimed at the management of populations of insects or of their habitats.

Most research on insect conservation has been on single species; very little has been done on communities or assemblages, separately or with their habitats.

Most research on insects has been on relatively easily found large-bodied insects and concentrated on two families, Scarabaeidae and Stenopelmatidae.

Most of the conservation work on insects has occurred in the last five years, certainly in the last ten.

Advocacy for insect conservation has been unplanned and uncoordinated and is only a recent phenomenon.

Future directions for conservation management, research and advocacy will have to be directed to finding ways for protecting maximum biodiversity because a species by species approach will not be affordable. This implies studying communities and habitats, increasing the standard unit for study many times.

The successful future of insect conservation lies in individuals and agencies working in a cooperative and collaborative approach.

FOR A COMPREHENSIVE ACCOUNT OF PUBLICATIONS ON INSECTS, SEE RAMSAY, GW AND CROSBY, TK (1992) "BIBLIOGRAPHY OF NEW ZEALAND TERRESTRIAL INVERTEBRATES 1775-1985, AND A GUIDE TO THE ASSOCIATED INFORMATION RETRIEVAL DATABASE BUGS", *BULLETIN OF TILE ENTOMOLOGICAL SOCIETY OF NEW ZEALAND* # 11.

SETTING PRIORITIES FOR CONSERVATION MANAGEMENT

BRIAN PATRICK
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Dunedin

OBJECTIVES

- Review the effectiveness of current conservation management activities by looking at some case studies.

- Discuss priorities for conservation management of threatened invertebrates and their habitats.

- Discuss the usefulness of current monitoring and research for management of threatened invertebrates.

- Come up with recommendations utilising seven workshop groups.

Let me list some of the broad issues that would warrant consideration of management intervention of invertebrates.

WHY MANAGE INVERTEBRATES?

- Some of the factors that allowed species to survive have changed (assumes recognition of these factors).
- Research or monitoring is showing clearly a decline in the population or quality of the habitat.
- Hazard risk considered too great.
- Damage to habitat from disturbance such as vehicular or pedestrian traffic.

We must remember to keep a flexible approach as, for instance, sometimes our priorities are set for us, for example, in the PNA programme. Here survey and implementation are carved out in a certain order so that at any point in this programme we do not have the advantage of the big picture.

Here are some of the key points of any invertebrate management programme:

- Must be nationally coordinated.
- Depends heavily on a spread of local knowledge.
- Assumes minimum funding available.
- Criteria must be applicable to insects (life histories, habits).
- Degree of dependence on research and monitoring results.
- Must be flexible enough to respond to sudden threats to species.
- Must not be hindered by lack of recent taxonomic treatment.
- Assumes knowledge of species linkage to habitat.

The Department of Conservation has already had its first attempt at setting priorities for research and management of threatened terrestrial invertebrates (Molloy and Davis 1992), in which the same criteria were used for vertebrates, plants and invertebrates. During this workshop, we will have a look at the criteria used and discuss the appropriateness of invertebrates.

RESEARCH AND MONITORING IN THE CROMWELL CHAFER BEETLE NATURE RESERVE

BARBARA BARRATT
AgResearch Ltd
Mosgiel

The reserve was established in 1982 because we knew that the Cromwell chafer beetle, *Prodontria lewisi*, had a very limited natural distribution; this was at risk of further limitation, possibly to extinction of the species as a result of habitat disturbance; and Charles Watt's research had provided some information on the phenology and habitat requirements of adults and larvae.

To manage the reserve in the best interests of *P. lewisi* further information was required:
- Distribution of *P. lewisi* populations within the reserve.
- Some measure of density, or population changes to monitor impacts of management.
- Methods of improving the habitat within the reserve to the advantage of the species.
- Impact of predators or other threats to the survival of the species.

Research has been carried out to assist with these questions:

DISTRIBUTION WITHIN THE RESERVE

Armstrong in 1986-87 mapped the distribution of populations within the reserve by night time observations and trapping.

This has helped focus Department of Conservation activities within parts of the reserve and to improve the habitat in others.

Also helped with rabbit control operation, poisoning in beetle 'hot spots' avoided.

RELATIVE ABUNDANCE

Armstrong carried out sampling survey in 1986-87 and again in 1989-90. This showed a significant increase in beetle activity.

Also looked at activity in relation to temperature which should help quantify the data.

This has allowed the Department of Conservation to make reference to the viability of the species which helped with negotiations over the Cromwell tip development.

Long term it will be a useful indicator to measure impacts of management inside and outside the reserve.

This population survey should be continued at 2-3 year intervals.

HABITAT IMPROVEMENT

A soil survey of the reserve showed that the reserve contains both old, and much more recent dune formations, the former are more suitable for tussock revegetation.

Eason (1986) studied methods of enhancing tussock establishment using irrigation, fertiliser and plant spacing treatments.

These studies have helped the Department of Conservation plan and implement their revegetation work, with the best chance of success.

PREDATORS

Watt recognised little owl as one of the most important predators. Armstrong followed this up with an analysis of chafer remains in owl castings. She found that *P. lewisi* fragments made up 10% of castings in spring/summer, and so was of importance.

The Department of Conservation has been able to justify the consideration of pine tree removal from near the reserve to discourage owls.

CONCLUSIONS

Research has made and will continue to make an important contribution to reserve management.

Population monitoring is an essential barometer for the reserve to measure the impact of management changes.

TERRESTRIAL INVERTEBRATE CONSERVATION A MANAGER'S PERSPECTIVE

BRUCE McKINLAY
Department of Conservation
Dunedin

I work on protected species and habitat management projects. I come from a background of birds, like most of my colleagues in this work: some, however, do have a background in plants.

My colleagues and I are desperately trying to broaden our horizons so that our management projects truly reflect the conservation needs of our conservancies, rather than just what has been traditionally done, or what we think the public wants us to do.

As with researchers on plants and birds, I want an active relationship with researchers on invertebrates. Obviously if I claim very little knowledge then I must rely on others to guide me in a particular field and to set practical parameters for getting effective outcomes. The other side of the coin is that if people who have developed a deep and long term understanding of, for example, an insect or group of insects - and who want to see this investment protected by not having 'their' animal disappear as a result of adverse land use or other causes - then these researchers or naturalists or whoever, should be talking to me about how to make this protection happen.

To be successful, then, the relationship must be two-way - otherwise neither of us will achieve our ends.

In Otago we are attempting to expand the nature and type of research and conservation management that is being undertaken on terrestrial invertebrates. The conservancy, as you have heard, is spending considerable effort on the Cromwell Chafer Beetle Nature Reserve.

I would be interested to know whether or not the group believes that this management direction and effort not only for the chafers but also the other topics from earlier this season is appropriate?

In Otago this expansion of effort into, for example, *Hemiandrus* wetas at Cromwell, chafer beetles throughout their range and *Mecodema chiltoni is* as a result of various threatened species fist priorities and plans. Some of these were directed at managers - for example, Molloy and Davis (1992); some are for researchers - the Department of Conservation research agenda 1993/94; and some are for both - Otago Conservancy business plan research agenda.

Plans may use different criteria to achieve different ends, but for me as a manager, the lists that provide priorities for future work are the most important. So is developing the right criteria for developing lists. The criteria used in Molloy and Davis are designed for all species. Are they appropriate for terrestrial invertebrates? If not, what changes are necessary?

An associated point is how to develop the lists which criteria are to be applied to. Do they exist? If not, how do we develop them?

Finally, there is a lot of invertebrate research and monitoring taking place. In terms of ensuring the conservation of the resource, is it effective? If not, what do we do about it?

PRIORITIES FOR MONITORING

GEORGE GIBBS
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Victoria University

As for any other part of the biota, insect monitoring is carried out

- to detect change
- to assess effectiveness of management.

A distinction was made between survey which sets out with no preconceived ideas to find out what is there; and monitoring which deliberately looks for specific standards by repeated surveys.

In the discussions, priorities are expressed in terms of principles or directives which apply to insects as distinct from other animals or plants.

WHAT TO MONITOR?

1. Ideally we should be attempting to monitor communities rather than species. However, it was realised that this ideal goal would seldom be practical.

2. Need to choose 'suites' of significant species (i.e. 3 or 4).

3. Entomologists should be able to provide information on which species are most appropriate.

WHERE TO MONITOR?

1. Ideally to be focused on biogeographic "hot spots" which will be determined by analysis of existing condition data.

2. In practical sense most monitoring will tend to occur where habitat threats are clearly evident.

HOW TO MONITOR?

1. Ideally, monitoring programmes should be designed to include a control area and they should begin before management activities begin.

2. There is a need for a manual of techniques to monitor (trap, count etc.) insects.

3. Monitoring programmes should recognise bias which comes from different observers, and the influence of many external factors.

4. Recommend making use of volunteers organised through local societies.

WHEN TO MONITOR?

1. Because of long life cycles of many of the target species and sheer lack of knowledge about life cycle biology, it is necessary to monitor over at least three years to include multiple year cohorts before any reliable trends will be detected.

In summary, entomological experience with monitoring is in its infancy. It is species-based and likely to continue that way despite the expressed need to move toward more of a community approach.

The greatest impediment to insect conservation is identification of the community and baseline knowledge of its biology (in comparison to other animal or plant groups).

STANDARDS OF MONITORING

JOHN HUTCHESON
Forest Research Institute
Rotorua

Although there are many agents of extinction that operate over evolutionary time, in historical time, no species of continental plant or animal has become extinct except by direct or indirect influence of humans (Wilson 1992). The major influence in the current extinction wave is habitat shrinkage and fragmentation, whether obviously through conversion for production, or less obviously through invasion of the habitat by incompatible species.

Gordon Hosking and I have conducted broad scale surveys of both pohutukawa (Hosking *et a1.* 1989) and cabbage trees (Hosking and Hutcheson 1992). In both cases regeneration only occurred where domestic stock were specifically excluded from sites. The protection existing for these areas would not have excluded either possums or goats. Less than 15% of 190 pohutukawa sites had regeneration present. Less than 5% of 760 cabbage tree sites had regeneration present.

It is perhaps axiomatic that once something has disappeared it no longer attracts attention. Absence cannot be recorded unless either a presence was previously recorded or a large scale survey shows obvious gaps in demographic pattern.

Our ecosystems evolved with, and to a large degree depend upon, continual disturbance. Although many of our trees have a first-line resistance to environmental problems by reducing crown to bole ratio through twig dieback and production of epicormic shoots (and good examples of this are puriri, pohutukawa, and cabbage trees) their ultimate strategy is the production of another generation. If the next generation has been eaten by cattle, any change in the overall environment that threatens the existence of the parent generation, spells doom for that population.

Kuschel's (1990) Lynfield study showed only 9% of 753 endemic beetle species persisting outside the indigenous habitat, and my work has documented at the community level the integration of our insects with their particular habitats. The two plant species surveyed therefore must be regarded as indicators of the fragile state of not only our more obvious vascular plants, but the entire indigenous biota of any of our remnant indigenous areas accessible to livestock.

The lesson to be drawn from this is that abundance and rarity are primarily functions of habitats. As Peterson (1993) states after evaluating environmental problems in eight different cases over two decades, 'independent management of the pieces in an interconnected web are doomed to failure'.

With an excess of 20,000 species to speak for, entomologists' only choice of action is to first direct our efforts to retaining our indigenous habitats. Money spent on this will conserve more genotypes than we could ever hope to monitor.

A more difficult situation exists of course where assessment of the effect of the means used to retain habitat is sought (e.g. the effect of 1080). Ideally comparative documentation of interspersed control and treated sites prior to, and after treatment is conducted. This is generally not the way either ecosystems or management tend to work. We begin with the difficulty of integrating management priorities with research requirements, and end acknowledging the fact that legislative language is ambiguous, and our adversarial system of conflict resolution will almost surely imply that the results of even the best of environmental assessments will be challenged (Peterson 1993), thereby utilising funds better spent on practical conservation measures.

Rather than entering the intricacies of balancing pragmatic techniques and ideal experimental design and analysis, I would direct interested workers to a series of papers in the Australian Journal of Ecology volume 18, 1993. These papers deal with a complete spectrum of issues mostly based upon assessment of the effects of pollution on marine communities.

Given the large size of our chosen field and the diminishing time frame and funds available, to be meaningful and pragmatic any monitoring study must deliver on two levels: firstly through documentation of the immediate focus of the study, and secondly through additions to knowledge of system structure and dynamics, because understanding of process and mechanism is a key to effective management (Peterson 1993).

I would like to conclude these remarks with a salient point generated from a discussion of ecophilosophy (Fairweather 1993):

- Science is not paramount. Decisions are made on a political basis, and philosophy and ethics can provide a stronger base for conservation decisions. This is because:

- Causal effects are difficult things to prove validly and defensibly without treatment interspersion (something rare in ecosystem studies).

- Science has great difficulty in many if not most situations in proving population or species loss to be deleterious.

Even if the latter proof should be possible, such losses can generally only be recognised after the fact. This is a philosophical problem which is being addressed by some enlightened management through the adoption of what Bodansky (1991) termed 'the precautionary principle' and which was perhaps best summed up by the American naturalist Aldo Leopold (1949) when he stated 'to keep every coil and spring is the first precaution of intelligent tinkering'. i. e. It's not just the big cogs that make something work!

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TERRESTRIAL INVERTEBRATE MONITORING AND CONSERVATION: WHICH TAXA? WHEN? AND WHY?

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Ecological impediment is a term recently assigned to the knowledge gap that prejudices our recognition of threatened invertebrates (see Hill and Michaelis, 1988). Among the conclusions of these authors in reporting on a survey of insect conservation needs by the Australian National Parks and Wildlife Service, is the following: "conservation educationalists should take a systems approach and emphasise the importance of all species within ecosystems".

I reiterate the same emphasis in terms of conservation monitoring. Conservation is essentially about systems and their sustainability, even in the context of our so-called 'threatened species'. Using insect monitoring data from tussock grasslands where I have worked for some 30 years, I have been able to draw several conclusions which I have published as conservation guidelines (White, 1987; 1991). Two of these guidelines are:

- conservation management should seek to monitor and maintain the common species of a community as a prerequisite for maintaining the rare species;
- the partitioning of conservation effort among conserved species should not be determined by rarity status *per se*, but by the risks of local extinction based on known ecology.

WHAT IS THE SUPPORTING EVIDENCE AND RATIONALE?

Firstly, a positive correlation has been demonstrated between the occurrences of rare species and common species in heterogeneous communities (White, 1987). In a systems context, the conservation advantage available to us is that community change is not only more readily observable with common species, but it may be more sensitively monitored.

Secondly, the survival of some species is more at risk, regardless of abundance. The values of different survival strategies (e.g., polyphagy vs oligophagy vs monophagy) are subject to changing risks when ecosystems are themselves subjected to change (see White, 1991).

For this reason, I shall approach the conservation questions of this workshop session by attempting to take the view of invertebrates themselves as the character of their ecosystems changes around them. It is a chronicle of 'rough times' (or even hostile times), of the survivorship of particular species in particular patches that are repeatedly changed. Many local populations have failed to survive the widespread advent of European induced changes. Yet in only 100 - 200 years of New Zealand's occupation, some endemic invertebrates have safely passaged through one, two or even three radical ecosystem upsets.

A very select handful have further survived a fourth fundamental shift, and the total progression is categorised in Table 1.

Column 1 assigns five names to these 'ecosystem classes' or states; column 2 defines their biotic features, plant and animal, endemic and introduced; and column 3 categorises some current examples of each. I recognise that labelling the progression in such a way will still mean different things to different conservationists, for we each start with our own perceptions of time-scales with respect to the names given each category. The time-frame we adopt (see Table 1 footnote) will govern our reference to real time. Notwithstanding this, I trust we are reasonably able to accept the sequence of progression states.

Columns 4 and 5 then draw some distinctions between the conservation policy goals of each ecosystem class, and their respective management objectives. In the recognising of such distinctions, I wish to emphasise that there can be no single set of responses to the questions of 'Which' invertebrates do we monitor, 'When' do we monitor, and nor to the question of 'Why'. The different states of a system deserve different answers, even when the taxa under threat comprise no more than a single species occurring within different ecosystem states.

Table 2 is an extension of Table 1, and seeks to present discriminating responses to the questions posed. But in order to answer those questions, we further face a dichotomy in the frames of reference we may each choose to adopt. Column 2 labels this choice as our Conservation Perspective. I guess most of us automatically assume the thinking mode of the individual taxon when we start to consider species as 'threatened'. This maybe perfectly valid. However, if we are to be systems thinkers as this paper would suggest, we must also recognise that community, ie. 'Fauna', is just as central as 'Taxon' to conservation practice, including the monitoring considerations. It is only in a context of the final two ecosystem classes (Remnant and Displaced) that the taxon perspective becomes our singular concern (see Table 2 footnote).

Which taxa should be monitored? Column 3 presents responses by categories. Note that even in the Taxon perspective of the Naturalised and Modified ecosystem classes, there is advantage in retaining a community framework of reference. The trends and dynamics of a given 'threatened' taxon may be best understood by simultaneously monitoring sympatric taxa. The broader information base using ecologically similar taxa (e.g., species/ genera/ families) can better provide a context for interpreting the monitored taxon of primary interest. Note further that column 3 definitions accommodate both primary and secondary consumers (i.e., parasites as well as plant feeders), and that the TAXON selections are progressively broadened as one moves from 'Natural' to Modified ecosystems (because increasing modification puts more species at risk).

Column 4 addresses the timing question. To monitor when? The systems approach may recommend various time-scales but with shorter monitoring spans always seen against the context of longer spans. Brief monitoring is of value; but repeated monitoring is of greater value than simply the sum of the overall effort. The returns to ongoing effort compound with time, and it is from the longer monitoring efforts that conservation theory and practice for the future will benefit most (White, 1986b). The anticipation of future ecosystem change will repay us well, and therefore it is recommended that provisions for longer-term standardisation be built into monitoring design whenever decisions are made on the initial effort for a 'threatened' species.

Note here that formalised guidelines to assess population survival risk levels (White, 1986a, copy appended) may be of help in the initial evaluation of 'threatened' species. Also in column 4 note that within the Taxon perspective, the longer-term frequency of monitoring Modified and Remnant ecosystems is governed by rates of change in endemic taxa; in contrast, the Fauna perspective in a Modified ecosystem looks to the introduced biota to govern monitoring frequency. This inference arises because the pace of change is determined in the wider faunal perspective by the invasive introduced biota as a whole (plant and animal, e.g., weeds and predators). On the other hand, in the more singular taxon perspective, the responses of the individual taxon are foremost because they may well vary in some way from the more general pattern of faunal response.

Column 5 attempts to express value - why monitor? I suggest that it is the responses of this column that above all others underscore the merits of a systems approach to monitoring. Only in reaching a satisfactory answer to the 'Why?' can the guidelines of tomorrow's conservation be solidly established. Not all monitoring will set out to provide this level of information, no matter how much we might wish otherwise. However, the growing New Zealand literature (Column 6) strongly demonstrates the merit of integrating guideline development within the overall commitment to monitoring, current and future. Failing this, conservation science will never consolidate beyond making ad hoc judgements based on the direction-of-the-wind and a notional sense of invertebrate scarcity. Note that no 'threatened taxa' literature has been cited. The monitoring questions 'which taxa?','when?', and 'why?' have not yet been addressed by any threatened species study. In fact, it is the evidence of other monitoring studies that has contributed more to conservation guidelines than have threatened species studies. It is also no coincidence that these contributions have come from the first three ecosystem states of the tables. Ask yourself. What is the lesson here?

As the workshop seeks to set priorities, I invite members to address their specific proposals within the framework of the two tables, clarifying and evaluating proposals row against row, column by column. What ecosystem states are you talking about? In a systems approach to monitoring, there can be no one conservation objective or answer for all situations.

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TABLE 1: A New Zealand-based progression of terrestrial ecosystem states over time, and some consequences for conservation policy and management.

Ecosystem class	**Features**	**Examples**	**Policy goal**	**Management objective**
* 'Natural'	Pristine endemic flora and fauna	Select offshore islands, any 'biotic island' with a long history of non-disturbance	Management against disruption	Keeping ecosystem free of intrusive elements or forces e.g. rats, 'development' proposals
Naturalised	Long-established introduced flora and fauna (including .predators) co-existing with endemic flora and fauna in a state of quasi-equilibrium over many decades	Limited-access habitats, isolated by ph sical extremes (herbfields, bluffs, by water (islands, wet-lands), by expansiveness (some tracts of endemic forest, scrubland, and tussock grassland)	Management against disruption	Keeping ecosystem free of any new intrusion e.g. eliminating founder organisms
Modified	Introduced flora and/or fauna expanding in 'recent' time (over years or decades) to the detriment of endemic taxa (flora and/or fauna)	All habitats in which endemic biota are reduced in prominence by cultural influences; also over time their more accessible neighbouring habitats (as an outcome of invertebrate dispersal)	Management for maintenance	Buffering the tendencies towards ongoing change e.g. grazing controls, predator manipulation
Remnant	Introduced flora and fauna dominant, the remaining endemic taxa at risk or restricted to low incidence	All habitats in which endemic biota are present but no longer prominent	Management towards replenishment	Promoting conditions that favour selected taxa e.g. re-establishment programmes
Displaced	Displacement of endemic biota is nearly total, except that certain endemic taxa prove to be highly adaptive	Mahoenui weta in gorse scrub, kiwis in pine forest	Management by targeting	Optimising conditions that favour the adapting taxon

* Recognition or omission as a separate class depends on the time-frame adopted, e.g. pre-1900 vs pre-European vs pre-Maori

TABLE 2: Suggested selections of terrestrial invertebrate taxa for conservation monitoring, according to ecosystem state (refer Table 1 for definitions) and conservation perspective (taxon vs fauna). # = see literature column for examples.

Ecosystem class	Conservation perspective	Selection of taxa (which?)	Timing (when?)	Value (why?)	New Zealand literature
' Natural'	TAXON	Ancient taxa, living fossils, localised taxa with highly specialised adaptations #	Open-ended opportunity unless ecosystem 'threatened' e.g. climate change	In the wider interests of conservation science	Russell 1986
	FAUNA	Choices largely academic	Open-ended opportunity	Referential base for future, but of narrow relevance, e.g. specific to offshore islands	
Naturalised	TAXON	As 'Natural' TAXON above; also 'threatened' taxa plus some of the non-threatened local taxa that likely to share some biological/ecological similarities e.g. species / genera / families	Long-term (decades), continuous but not necessarily high input, anticipates eventual ecosystem modification #	Understanding the survivorship of rare species relative to common species #	White 1987; White & Sedcole 1991
	FAUNA	Group indicators of faunal dynamics e.g. grassland moths to represent primary consumers and key prey resources #	Long-term opportunity, not necessarily high input, may be periodic only, anticipates eventual ecosystem change #	Referential bases for future comparisons, wide relevance #	Barratt 1983; Hutcheson 1990; White 1986b, 1987, 1991;
Modified	TAXON	As 'Natural' and Naturalised TAXONS above; also pollinators of threatened plant taxa	Urgency dependent on perceived 'threatened' species risks, thereon frequency dependent on rates of change in monitored endemic taxa #	Indicator of specific conservation needs and urgency	White 1986a
	FAUNA	As Naturalised FAUNA above #	Frequency dependent on rate of change of introduced biota #	Determining local loss rates and trends of endemic faunas, wide relevance possible #	Barratt 1983; Hutcheson 1990; White 1991
Remnant	TAXON	As Modified TAXON above	Urgency and frequency dependent on rate of change of 'threatened' taxa #	Indication of specific conservation needs and urgency	White 1986a
	*FAUNA	-	-	-	-
Displaced	TAXON	Adaptive taxon	Frequency lessens as establishment consolidates	Testing and optimising the success of conservation practice	
	*FAUNA	-	-	-	-

* Endemic fauna no longer viable as a conservation interest

INSECT COMMUNITY CHARACTERISATION ACHIEVABLE REALITY

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Recent developments in insect sampling and analytical techniques allow us to quantitatively represent similarities and differences of communities based upon their structure and the affinities of particular species and species assemblages for particular habitats (Hutcheson 1990 & in prep.).

The method involves the collection of four consecutive weekly samples of malaise-trapped Coleoptera from the habitat in question during December, the beginning of the main activity period. Sample analysis includes multivariate techniques, particularly the polythetic divisive classification procedure TWINSPAN (Hill 1979).

WHY THIS APPROACH?

It has been demonstrated (Tanaka and Tanaka 1982, Moeed and Mead 1985, Neumann 1979, Hammond 1990) that Coleoptera may be used as indicators of overall community structure, sometimes referred to as 'indicators of habitat quality'. All functional groups of communities, ie. detritivores, herbivores, predators etc. are represented within this order, and the dynamics of sampling are better understood than with many others.

Taxonomy is based on standardised 'Recognisable Taxonomic Units'(RTU's) a concept now widely accepted as a means of bypassing the 'taxonomic impediment' (Ramsay 1986) which in NZ is a consequence of approximately 50% of our fauna being undescribed (Watt 1982). Where possible, species were named, but in many cases were simply given code numbers within family. The general approach was one of 'lumping' species together rather than 'splitting' them.

Malaise traps were utilised because they returned the most representative samples of the functional range of Coleoptera communities for the investment of time and energy (Hosking 1979, Hammond 1990).

A pilot study indicated that one week was the best sampling period. The sampling window during the ascending activity period was arrived at after a study involving sampling over the full season in two sites showed this to return the most characteristic samples. Two way indicator species analysis (TWINSPAN) differentiated between the sites based upon the samples, indicating that real differences exist between communities which can be recognised using the sampling period, technique, and analysis as per Hutcheson (1990).

The sampling window has been confirmed as delivering the most characteristic samples by subsequent sampling series. Reasons for this are: seasonal community change is less of a factor, small samples from the beginning and end of the season are excluded, and the mixing of highly vagile species that occurs toward the end of the season is not a factor.

Four consecutive samples/trap were found to be necessary to provide sufficient representation of the community and corroboration of the classification pattern. The samples processed to date were divided into groups primarily associated with habitat, and secondarily associated with sites within habitat type.

At a finer scale, the technique has differentiated between samples from sites within the same vegetation type, but having different attributes in terms of vegetation health. The important feature of this is that the biologies of the compositional species reflect attributes of the habitat and this can be displayed in the functional structure of the samples.

Because the insect community is continually integrating and responding rapidly to all environmental and biological inputs, they potentially provide an extremely sensitive monitoring system.

A pragmatic sampling and analysis approach capable of consistantly discriminating between samples in an ecologically meaningful manner, and which allows interpretation of the samples in terms of the habitat and its particular parameters, opens the door to comparative studies in a myriad of different areas. These studies may contribute not only at the level of basic ecological information on distributions and diversity within what is the dominant measurable sector of DOC's genetic estate, but may also contribute directly to DOC's decision making process by providing information on aspects of habitat quality required for prioritisation of resources, that are not evident from the vegetation and/or vertebrates.

For realization of the full potential of this tool for investigation of our ecosystems, it is vital that the underlying taxonomic expertise concentrated with the NZ Arthropod Collection be accorded the importance and support required for it to survive at more than simply a subsistence level.

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MECHANISMS FOR PROTECTION

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I come to the issue of threatened insects from what might be called an administrative rather than a scientific angle. I would like to raise some discussion about mechanisms for protection for threatened insects, and invertebrates generally. Recently I was responsible for seeking some possible amendments to the Wildlife Act 1953 in terms of the species that are protected under that Act. You will know that the Seventh Schedule provides a list of invertebrates that are protected.

The responses I received from people with interests in invertebrates were very interesting for their lack of unanimity. While those who were interested in birds and reptiles did of course differ in their perceptions of individual species, no-one questioned the value of legal protection in itself. This was the case with invertebrates, though. Within a diverse range of replies there seemed to be three schools of thought that could be summarised.

One group of respondents made the point, quite correctly, that protection under the Wildlife Act does not prevent the effects of habitat destruction and predation. They usually went on to state that scientific collection does not constitute a threat to the survival of insects, and that legal measures such as this serve only to hamper bona fide research efforts.

The second group felt that there could be some use in protection, but clear guidelines are needed for criteria under which species could be suggested for listing.

The third group felt that protection in this way is useful, but the very large number of possible candidates need to have some selection process; another query on criteria.

Those in the first group felt that protection of individual species is not appropriate, and that protection of habitat is the key point at issue. I certainly take the point, but we also need to consider that the protected areas we have were not been selected on the basis of being representative of all habitat types. There seems to be a fairly conspicuous lack of success in protecting natural areas for anything other than scenic purposes. Another difficulty, of course, is that some of the habitat types themselves have almost disappeared, for instance forest on fertile lowland sites.

So I think that advocating the protection of all species through habitat protection is rather too simplistic. Acquiring and reserving the habitat itself is no more effective in controlling introduced predators, for instance, than protection of the species under the Wildlife Act would be. A commitment to some form of long-term management is still necessary.

Because of this commitment, efforts to reserve secure habitat for an insect can often be more successful after its protection under the Wildlife Act. Perhaps negotiations can be undertaken with more success if the species has its conservation status given legal backing, and notification that its survival is in the public interest. The recent successes of the Otago

Conservancy in securing habitats for insects that are of interest, even though unprotected, are noteworthy.

As far as the impediment to scientific research is concerned, I would just mention that our knowledge of many endemic birds has increased considerably since protection of the first few species was instituted in 1863.

While collection may in the majority of cases pose no threat, I think that in the case of easily identified and notably scarce insects, the precautionary principle should prevail. I would hate to see another example along the lines of the great auk, the Northern Hemisphere's penguin analogue.. The ultimate extinction in 1844 of this unfortunate bird was due to the high demand, and accordingly high price offered by museums and other institutions of the times for specimens, and so it was persecuted in its last refuges.

So, having I hope, quickly countered the criticisms of those who see the protection of insects on an individual basis as being not worthwhile, there clearly are others who feel it would be useful, given some criteria under which we could assess candidates that might benefit from legal protection. And "benefit" in this context could cover many other aspects beside the more obvious biological criteria that we have discussed earlier. I am grateful to Dr Graeme Ramsay of the then Mt. Albert Research Centre for providing the basis of the following listings:

Ecological Reasons

Species at risk because of

- natural rarity
- loss/modification of habitat
- human collection/exploitation

Administrative Reasons

Species needing

- secure habitat
- monitoring/management
- habitat enhancement
- control/management/prevention of human exploitation

Other Reasons

Species that could be of interest for

- spectacular species
- unique/special/peculiar/interesting species
- public education

I would like to invite some discussion along these lines. Some of the difficulties of taking this approach need to be noted too. Clearly a fist of the least-known and most seldom-encountered species would not make for an effective measure of success in promoting their survival. Species that are at risk primarily because of their natural rarity are the most problematic. Once a species has been listed as protected, then the commitment to encouraging its recovery cuts both ways, and credibility (I hope some remains) needs to be maintained. Little would be gained by adopting a list of species regarded as being the most likely candidates for extinction.

There needs to be a modicum of knowledge about the species and its needs in terms of habitat and threats to its survival. Attention might also need to be given as a general principle to species that are large-bodied, because of their sensitivity to disturbance and introduced predators such as rodents, and their "collectability".

Problems with identification have also been raised. If a species can be separated from its more familiar relatives only by means of a microscope and reference collection, then it couldn't qualify as a good candidate for legal protection. If, however, it is one of a number of related species of sufficient interest, then protection of a larger grouping such as a genus should be considered.

CATEGORIES OF THREAT

The categories of threat which we use, and which jointly make the list of "Threatened" species are based on those used by the Conservation Monitoring Centre of the International Union for Conservation of Nature and Natural Resources (IUCN) in their worldwide survey of threatened species.

Presumed Extinct (P): This category is used only for species which are no longer known to exist in the wild after repeated searches of the type locality and other known or likely places. It includes species extinct in the wild but surviving in captivity/cultivation.

A species may be listed as extinct in one country while surviving in another. Extinction can never be regarded as more than a probability, and rediscoveries are occasionally made.

Endangered (E): Species in danger of extinction and whose survival is unlikely if the causal factors continue. Included are those whose numbers have been reduced to a critical level or whose habitats have been so drastically reduced that they are considered to be in immediate danger of extinction.

We include all species whose populations are so few or small, that loss by natural means, such as inability to breed due to lack of genetic diversity or a natural catastrophe becomes possible. We consider it is useful to include species whose survival in the wild depends on habitat manipulation or continued management.

Vulnerable (V): Species believed likely to move into the Endangered category in the near future if the causal factors continue. Included are species of which most or all the populations are decreasing because of over-exploitation, extensive destruction of habitat, or other environmental disturbance; those with populations that have been seriously depleted and whose ultimate security is not yet assured; and those with populations that are still abundant but are under threat from serious adverse factors throughout their range.

It is sometimes difficult to draw a line between what is Endangered and Vulnerable on the one hand, and what is Vulnerable and Rare on the other. Vulnerable is essentially a dynamic category implying change and the need for active protection. Rare species may not need urgent protection although they will require monitoring.

Rare (R): Species with small world populations that are not at present Endangered or Vulnerable but are at risk. These are usually localised within restricted geographic areas or habitats or are thinly scattered over a more extensive range.

Indeterminate (I): This category is used for species thought to be Extinct, Endangered, Vulnerable, or Rare, but for which there is insufficient information to allow allocation to a category.

Insufficiently Known (K): Species placed here are suspected, but not definitely known, to belong to any of the above categories. There is insufficient information to be certain.

MECHANISMS FOR PROTECTION

Participants broke into five groups to discuss the topics summarised below, with the more closely related issues being discussed together.

1. Can a single species characterise special ecosystems and communities?

This may be a useful method to introduce an emphasis on community ecology to the general public. Public advocacy has up to the present concentrated on the more captivating animals such as kakapo and black robin, because they attract the most positive response.

Public advocacy has to date given little emphasis to the conservation of communities and ecosystems as a whole. If a particular community or ecosystem could be characterised with a single species as its focal point, that could be a step toward community conservation. To do this effectively, the focus of advocacy needs to be slowly shifted away from the more appealing animals.

An appropriate "key" species would need to be one whose management for an improvement in status could be spread across the whole community. Such an example would need to be typical of the habitat, distinctive and specialised. The ecosystems most suited to this approach would be small or restricted, such as bluffs and caves, or soil types such as salt pans and ultramafics.

Another point that would be helpful in focusing on habitat conservation would be to concentrate on the species that are most at risk from agents of modification. For example, fire is the major modifying influence in tussock grassland, and so the most appropriate species to concentrate on in these areas would be those most at risk from fire: e.g. *Powelliphanta spedenii* and *Mecodema chiltonii.*

Conservation Management Strategies currently under preparation are a good start in terms of identifying priorities such as habitats requiring protection. A list of "flagship species" or those representative of restricted habitats would assist in the process.

2. What factors make species good candidates for protection (separating natural from induced rarity)?

Endemism and rarity, although valid considerations, are better understood as ranges of values rather than absolute positions.

Special situations are worth considering, for instance where an insect is confined to a single rare host plant, or is pollinator of an uncommon plant. Insects with interesting bio-geographic associations could also be useful additions to the list.

Insects with a high profile for other reasons can be considered, for reasons of public support.

Insects could be represented because of their importance at trophic levels. This could be at the bottom as herbivores on single restricted species, or at the top as in the case of the hyper-parasitic wasps which depend on the eggs of other insects to rear their larvae.

In the absence of other data, the sensitivity of the species to induced threats, whether actual or potential, could also be taken as a starting point for consideration. The rate of population change would also be an important issue. Although this is not an easy point to get answers to, if old records exist this can be measured, particularly if the habitat has been reduced or numbers declined.

Lack of knowledge is recognised as a limitation, but it was agreed that even if an insect appears on a list, it can be removed if later information shows it to be in a better state than first thought.

3. Does scientific collection and study threaten insects as well as conserve them?

The perception of rarity can often be merely a reflection of our lack of knowledge. When a species is considered rare, two lines of approach are usually taken; moves to protect the species, and study to learn more about it.

Collection by entomologists is probably not causing extinctions, but there is clear potential for over-collection in some cases, for instance the cave spider *Spelungula cavernicola*, restricted to a few caves in the Nelson area. An element of habitat destruction is also possible in some forms of collection. Extreme caution needs to be exercised in this case if habitat is limited, for instance investigation of fallen logs where the numbers are limited and unlikely to increase. Collection in ignorance of these sorts of requirements can damage ecological and behavioural conditions.

Lists could be compiled of insects believed to come into this category, and their study should be focused toward conservation rather than collection.

It was suggested that the Wildlife and Reserves Acts may act as an impediment to knowledge-gathering through restricting collection. Basically all knowledge of entomology comes from the collection of insects. Collection is understood to be generally more helpful than deleterious; new records of species found outside reserves may not be made if the species are protected overall, needing a permit to collect.

Legislation can prevent enthusiastic amateurs from becoming involved. Difficulties, too, may be encountered with identification of protected insects in the field if they need to be dead to identify, or are accidentally taken in a kill-trap. The criteria for listing protected species need to take account of these problems and only include insects that are easily identified in the field.

A blanket permit system could be introduced, in which accountability would rest with the collectors. Collections would be made under the terms of the Entomological Society's collection code, and permit-holders should be registered, or approved through the Entomological Society. It is important that both the information and material collected ultimately becomes the property of the state, to allow its access by all.

Recommendation;

> That the department consider making provision for entomologists to be granted blanket permits to collect, in similar way to plant collectors. Renewal of a blanket permit should be contingent on holders reporting back, and the Entomological Society is willing to vet applicants.

4. Is advocacy a threat to insects?

There was a clear consensus from the workshop that advocacy does not represent a threat to insects with restricted distribution, if handled sensitively. The normal caution would need to be observed in giving out site information, making sure that it is not too specific.

The important point was made that advocacy needs to underpin the whole of DoC's conservation strategy. The public need to be helped along the way to respecting and paying attention to the less obvious and less attractive species. All have their roles in the functioning of an ecosystem.

Alison Ballance's work in raising the profile of weta with the public through advocacy was commended, and it was felt that some re-thinking of DoC's advocacy strategy along the same lines could have positive results.

5. What are the preferred mechanisms for protection?

This question was addressed by two groups:

Group One

This group began by considering current legislation. Land-based legislation such as the Reserves Act, Conservation and National Parks Acts provide automatic protection from human interference for all manner of resources within the extent of their tenure.

The Wildlife Act takes a different approach through its protection of listed species wherever they occur. Positive aspects in this approach are the ease of statutory advocacy, being able to gain habitat protection through Planning Tribunals and the like. The lists can provide a focal point for species management, and direct negative effects such as over-collecting can be prevented.

Negative aspects are that the list will always be incomplete, not keeping up with latest information, and the list can be given too much prominence, in that species not listed are given little value.

An Endangered Species Act was seen as an alternative. Although the negative aspects would be the same as for the Wildlife Act, the degree of advocacy could be stronger, and regular reviews could be written in to improve the workability of the lists.

Another suggestion was that of an Act to give blanket protection for invertebrates, with exceptions for designated areas or activities, rather than a species-based list. A list of threatened species could be picked out on departmental lists at the same time.

Greater leverage could be given to habitat protection in this way. It was suggested that developers and others who would be damaging habitat would need to apply for a dispensation under the Act. This would give an opportunity for evaluating the site for its values, which could cover a wider scope than simply individual threatened species, e.g. significant communities.

This would assume a significant change in philosophy, to that of recognising the importance of all invertebrates. It was recognised that this approach may be running a little ahead of public attitudes, and so may not gain acceptance.

Group Two

This group took a slightly different approach by identifying the needs that should be addressed by any legislation to protect invertebrates, rather than looking at specific provisions.

A need to shift activity to pro-active conservation was seen, and it was suggested that blanket protection of invertebrates could achieve this. An important point is that the tactical advantage needs to lie with conservation. The burden of proof should be shifted on to developers to prove no damage would occur as a result of their actions, rather than the present situation where a case has to be made showing that damage would result, before an activity can be restrained.

Invertebrates need to be elevated to first class status, and motivation provided to stimulate study and research on invertebrates. Blanket protection could be the way to spur this into action; mechanisms are in place in terms of Conservation Management Strategies, District Plans, Recovery Plans and the like, and experienced entomologists are available.

Blanket protection can afford to be selective about taxa, listing exceptions to the general rule of protection where this is justified. This necessity could provide the support for increased resources on investigations into invertebrate ecology.

As a final point, this type of approach could move the department out of the currently rather insular "reserves" mentality into the wider mandate of a stewardship approach, where some responsibility is accepted for the protection of invertebrates and natural values outside reserves and protected areas. Ecosystem fragmentation is likely to increase in future without more pro-active conservation measures.

Discussion

In the discussions which followed the workshop sessions, there was a clear recognition that the gathering of knowledge about invertebrates needed to be encouraged, in order to;

- increase our understanding
- improve the public image of invertebrates
- gain stronger leverage for recognition of special ecosystems and communities.

Speakers saw a clear need for the Entomological Society and DoC to maintain closer liaison to help address some of these deficiencies. Besides fostering closer association and better communication, it was also suggested that reciprocal advantages could be gained in the current climate where knowledge is seen as a commodity that must be purchased.

It was recommended:

That systematists and others knowledgeable about particular areas or groups of species should contact local DoC staff and arrange to pass on some of this practical knowledge in the field.

SETTING PRIORITIES FOR RESEARCH

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Two main objectives are to:

- define the most important areas of research relevant to the conservation of New Zealand's terrestrial insects, and
- assess the value to managers of recent past and current conservation research into insect conservation with a view to improving the design of future research.

We can look at ways of achieving these objectives by dividing possible research areas into a variety of categories. While there is obvious overlap among the different classifications, they serve as a preliminary guide to looking at areas of research that are worth pursuing further.

THREATENED SPECIES

This category includes large-bodied insects threatened because they are prone to predation, have specific habitat requirements, limited dispersal abilities, limited distributions etc. Research topics to date include habitat use, genetics, threats (e.g., predation and habitat loss), benefits of habitat management, success of translocation attempts.

GROUPS OF SPECIES

This includes allied species with common characteristics - e.g., taxonomy :*Deinacrida connectens* complex, ground weta - or insects in various types of habitat in the same geographic area, such as coastal Wellington: while such species occur in different habitats they face similar and various threats.

COMMUNITIES

These are unique combinations of insects with perhaps their host plants, prey species or host animals. They may occur in high risk areas like lowland forest and swamp, high country grassland, tidal influenced areas.

HABITATS OF SPECIES OR COMMUNITIES

Rather than specific assemblages or communities (combinations) of insects, a specific category of habitat like lowland podocarp forest, kahikatea forest, duneland, raupo swamp may overlap with other categories and contain unique species or combinations of species. More particularly, the habitats themselves are special and unique, as are insect species that may occur there.

INTRODUCED PROBLEM SPECIES

These include introduced pest species - e.g., vespulid wasps and ants, introduced mammalian predators (rats, hedgehogs). Weed species destroying habitat are another possibility for consideration..

Questions include: impacts on abundance and diversity, which communities are at greatest risk, how these communities are affected, means of best controlling pest species impacts, which communities are most affected with pest species.

TOXINS AND HABITAT MANAGEMENT

Toxins have been and still continue to be used widely during habitat management: mammal control or eradication and weed control, water levels may be modified on a wide scale with drainage, habitats may be lost due to afforestation or land stabilisation or overgrazing.

Questions include what impacts are there on non-target species from using 1080 and anti-coagulants, remembering that 1080 is designed as an insecticide. What are the relative trade-offs from browser control using 1080 and no browser control in terms of species diversity? What land management practices most affect native species communities (abundance and diversity) e.g., drainage, overgrazing.

CHANGES IN THE ENVIRONMENT (MACRO SCALE)

Changes in climate are occurring both for "natural" and human-caused reasons. These changes may include warmer temperatures, higher rainfalls, levels of radiation, greater extremes, etc.

Questions include what monitoring should be done to gauge the impacts of changes on native species and communities, and whether there are any impacts of climate change on native fauna.

OTHERS

Special cases may occur ("one-offs") - e.g., questions concerning cave-dwelling carabids. Research requirements for aquatic insects include research on the genetic variation within and between catchments, and the habitat requirements of adult stages of aquatic insects. Habitats requiring protection include small lowland forest streams. Kevin Collier of NIWA advocates a habitat based conservation approach to protect greatest diversity of aquatic fauna.

AUDITING CONSERVATION RESEARCH

It is important to audit research and ask the question "how effective is our research in meeting management and advocacy requirements and reducing the threats to the conservation of our native insect fauna".

AN IDEALISED FOUR STAGE APPROACH TO CONSERVATION RESEARCH ON INSECTS

Note : all stages are interactive with feed-back loops operating between all stages

Planning - designing research in response to perceived demands from managers, scientists and public.

Investigation - carrying out the research and publishing results and recommendations.

Implementation - materially carrying out the recommendations of the researchers recommendations.

Advocacy - publicising results and management action to the public and politicians.

Placostyius AND *Deinacrida*: CURRENT MANAGEMENT, SUCCESSES, PROBLEMS AND THE FUTURE

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Placostylus: FLAX SNAILS

The conservation status, management and research on flax snails have been described in Sherley and Parrish (1989) and in four large file reports, copies of which are available from the Department of Conservation at Whangarei or the Science and Research Division.

Management

Since 1988, the following management tasks have been undertaken:

- Habitat protection: fencing four populations (subspecies) hence pigs and stock kept out of habitat.

- Predator control: poisoned rodents (pulsed - four times a year using brodifacoum), directed pig hunting.

- Translocation: three subspecies have been moved - techniques and details appear in Sherley (1993).

- Captive rearing: one colony is being maintained in captivity.

Success

A draft recovery plan for Northland snails has been written.

It appears that *Placostylus ambagiosus paraspiritus* has responded to the control of its predator and has increased the proportion of sub-adults in the population compared to another population which is still being preyed on (unpublished data reported in aforementioned file reports). Pigs and stock have not yet penetrated three of the four exclosures. One of the three translocation attempts shows the beginnings of success with transferees starting to produce offspring surviving to advance juvenile stages.

Captive rearing could be deemed totally successful when F3 and more generations are bred. To date, Fl generations have been bred, are showing no signs of unusual mortality and are growing wet Valuable ecological data are being collected to augment those gathered from feral populations.

Problems

Creating fences in remote bush-clad areas is extremely expensive and compromises the quality of the fence. Maintenance of the fence is forgotten in the costs and continuing management requirements of the threatened species. Fencing out feral pigs is very difficult. Fences may be culturally insensitive because of spiritual values which are based on unmodified landscape.

Pigs cause a two-fold problem because they destroy the habitat as well as feed on the snails. Pigs roam huge distances. Therefore their control has to be based over a wide area which is costly and may cause conflict with sporting hunters. The latter problem has been reduced by getting pig-hunting club members to direct their efforts to high risk (from the conservation of snail's point of view) areas where threatened colonies occur.

Translocation requires monitoring and therefore finding animals at necessarily low densities. Our techniques are inadequate for this and new methods are urgently needed. Translocated snails apparently disperse, sometimes out of the exclosure back into high risk predation areas, hence their dispersal behaviour when translocated needs to be better understood to avoid this problem.

Monitoring for any reason, be it translocation or research, is absolutely necessary yet the very techniques used are damaging to the snail habitat. A less invasive method of monitoring is required to reduce this problem.

Captive rearing initially experienced unexplained death of wild-caught snails but this problem seems to have disappeared.

Using toxins over long periods for mammal predator control may select for resistance against the effects of the toxin and hence compromise the long-term conservation of the snail populations.

Future

- Monitoring to continue assessing the success of rodent poisoning in terms of snail recruitment.
- Continued translocation of wild captured snails but using captive reared animals in the long-term.
- Rodent poisoning at most known colonies.
- Directed pig hunting.
- Designing a monitoring system (statistically) and method (finding snails reliably and with minimum damage to habitat).

MAHOENUI GIANT WETA (*Deinacrida* N.SP.)

Habitat Protection

- Fencing the reserve where the weta occur.
- Creating firebreaks.
- Continuing a traditional stocking regime (cattle) and retaining a feral population of goats.
- Translocation to create two founder populations.
- Captive rearing to enhance research and translocation efforts.

Success

- Acquisition, firebreaks and fencing in the reserve achieved within two years of rediscovery.
- Draft recovery plan written.
- Agreement with land user to retain traditional stocking regime.
- Control of feral goats at a stable density.
- Successful breeding at two translocation sites.
- Captive breeding successful and able to be used for translocation programme.

Problems

- Monitoring weta at low densities.
- Weta habitat (gorse) is an early successional community and prone to dramatic change over a short period of time. Hence the safety of the weta population is jeopardised.
- Feral goats are a pest species and are liable to destruction from neighbours.
- Captive reared wets populations have a boom and bust pattern so that maximum numbers must be taken at precisely the right time.
- Captive reared congenerics have been reared in the same enclosure and cause doubt about the taxonomic identify of the offspring.

Future

- Translocation of captive-reared weta and salvage weta from habitat destruction.
- Studying the dynamics of the reserve's feral goat population and their role in maintaining ideal weta habitat.

GENERAL POINTS

Monitoring invertebrates at low densities poses a formidable problem for management because all management practices at some point totally rely on monitoring to gauge success.

Captive-rearing can be a powerful research and management tool if properly organised in conjunction with the whole conservation programme (management, research and advocacy).

- Research and management should be integrated completely for maximum conservation effect.

Other invertebrates intensively managed in New Zealand to date include the Wellington coast speargrass weevil *(Lyperobius huttoni)* and two weevil species on Breaksea Island, western Fiordland. The former became extinct in the special reserve purchased because of lack of management following purchase and the later are being maintained at present since their introduction to the rat-free island from adjacent islands. It is obvious that purchase and gazettal of a reserved for invertebrates, although expensive and time consuming, is the easy part of the exercise in fully protecting invertebrates. Follow-up monitoring, research and subsequent management are extremely frustrating and difficult.

HOW MANY SPECIES OF GIANT WETA ARE THERE?

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Giant weta of the genus *Deinacrida* are the main focus of New Zealand's invertebrate conservation efforts and the flagships for its advocacy. Six of the seven named species are protected under the 1980 Wildlife Act Amendment. The most recent taxonomic review of the genus is that of J.T. Salmon (1950). However, since that was published a series of reports and specimens thought to represent new species have come to light but not been adequately reviewed, hence creating a sense of mystery over the true extent of this important genus. One of these discoveries is the well-known "Mahoenui weta" which has been the subject of a major insect conservation initiative (Sherley & Hayes, in press). This paper summarises our attempts to unravel the identity of these "new" species and to review the diversity within the genus. Whenever possible, we obtained live specimens for genetic analysis, using allozyme electrophoresis and karyotyping to differentiate between taxa. Because most species are protected, some of the sample sizes have been very small. We appreciate that this will not be the last word on *Deinacrida* species but it should serve to clarify some areas of present confusion although without providing formal names.

Table 1 shows the current named species based on Salmon (1950) together with a series of "informal" taxa represented in collections or cited in various reports. It is these uncertainties that we focus on here. We are retaining the current interpretation of the genus *Deinacrida* (giant weta) as those weta (Stenopelmatidae: Deinacridinae) with the following diagnostic features: prostemum with two spines; pronotum wider than head; no enlargement of the head in the male; middle tibiae with a pair of superior apical spines. These characters contrast with *Hemideina* (tree weta) as presently defined but it should be pointed out that the genetic data on these genera do not conclusively confirm that they are monophyletic.

"MOUNT COOK WETA"

In recent unpublished reports there have been references made to a "Mt Cook weta" (heads, 1990; Rasch, 1992) which is distinct from the giant scree weta, *Deinacrida connectens,* also found on the mountains of that district. Our attention was drawn to this weta by a colour photograph taken by Don Robertson in the head basin of the West Matukituki Valley in May 1965. The weta shown was a rich brown colour and lacked the black head vertex of *D. connectens.* In response to this record and a similar weta shown in a photograph taken by Jan Heine from Price's Basin, Whitcombe Valley in March 1991, we visited these two localities in April 1992 to obtain some live material for analysis. At both sites large numbers of the weta were found under stones by day. Its smooth texture and all-over brown pigmentation distinguish it from other giant weta, giving it very much the appearance of a tree weta. This similarity is heightened by the nature of the stridulatory file which consists of from 4-9 parallel ridges on the margins of the second abdominal tergite. However, it carries the diagnostic *Deinacrida* features given above so must be regarded as

TABLE 1 Named species of *Deinacrida* with the informal taxa and specimens which are investigated in this paper.

1. *heteracantha* White, 1842	"Mahoenui" 1962
2. *fallai* Salmon, 1950	"Mt. Cook" 1946
3. *rugosa* Buller, 1871	"Kaikoura bluffs" 1953
4. *parva* Buller, 1895	"Mid-Canterbury" 1957
5. *tibiospina* Salmon, 1950	"Headlong Peak" 1980
6. *connectens* (Ander, 1939)	
7. *carinata* Salmon, 1950	

Note: dates of informal species refer to the earliest record.

a giant weta by that definition. Females reach a total length of 52 mm (excluding ovipositor) and at maturity weigh 12 g. When all records are collated, it is evident that the "Mt Cook weta" occurs between 700 and 1400 m in very high rainfall areas on both sides of the main dividing ranges of the South Island between the Taramakau valley in the north and the Cleddau valley in Fiordland. Its habitat is distinctly more vegetated than that of *D. connectens* but it is conceivable that both species could be found together. So far, the "Mt Cook weta" is known from subalpine shrublands in head basins, up to snowtussock communities where suitable patches of loose rocks are available for cover. The earliest specimen, which is almost certainly referrable to this species, appears to be an immature male taken by J.T. Salmon in the Cleddau Cirque in 1946 (Museum of New Zealand collection).

"KAIKOURA BLUFF WETA"

Live specimens of this most colourful of all our weta species were first taken in 1988 at Kahutara Saddle as bycatch during a search for black-eyed gecko by Tony Whitaker and Greg Sherley. It has since been found in the Hapuku and Hodder catchments (Meads & Notman, 1992). A sunbleached skeleton from the Hodder valley found by Sheila Natusch in 1953 (MONZ) is also referrable to this species. The bluff weta is a large, active species with a female body length of 55 mm (excluding ovipositor) and weight of 16 g. The adult is pale grey, suffused with rusty brown on the tergites, but it is the bright orange-red pigment tipped with black on the sides of each femur which really sets this weta apart. Like the "Mt Cook weta" its abdominal tergites are smooth and the stridulatory file consists of about seven parallel ridges. The diploid chromosome number for both these new weta species is the same with 2n = 23 (male XO) or 24 (female XX) but their respective karyotypes are quite distinct.

The "Kaikoura bluff weta" has been found between 1220 and 1600 m in deep fissures and crevices of stable rocky outcrops. Such rock is rare in the eroding scree-covered Kaikoura Ranges so this habitat specialisation isolates it spatially from the scree weta, *D. connectens*, and the Kaikoura giant weta, *D. parva,* which also occur in the same Ranges. However, the isolation is only in its retreats since "Kaikoura bluff weta" and *D. connectens* have both been observed feeding together at night (Meads & Notman, 1992). Bluff weta have been seen out by day but are normally hidden deep in the crevices which may be shared with the black-eyed mountain gecko.

Immatures of the "Kaikoura bluff weta" are even more vividly coloured than the adult with a pattern of black, red and white which brings us to a consideration of another unnamed South Island giant weta. This one, referred to by Meads (1990) and Rasch (1992) as the "Mid-Canterbury weta", had been taken at Mt Somers in 1957, but not seen since. The specimen (National Arthropod Collection) was obtained on loan and efforts were made to trace the discoverer, V. Hunt. A few enquiries in the Mt Somers district revealed that Mr Val Hunt used to be a tramper in the region and now lives in England. When contacted, he remembered precisely the details of where the weta was found and what it looked like. His specimen, an immature male in alcohol, is morphometrically compatible with an immature of the "Kaikoura bluff weta". Moreover, Mr Hunt remembers it being very distinctively coloured (hence his interest in it) "black and red, maybe with some white". It is possible to discern that the faded colour banding of the legs of the 35 year-old specimen precisely matches that of an immature bluff weta with its striking black and white femoro-tibial joints. We therefore conclude, until further material is found to confirm or deny this hypothesis, that the Mt Somers weta should be regarded as conspecific with the "Kaikoura bluff weta". Its habitat, in black beech forest at 600 m a. s.l. is totally unexpected from what we know of the ecology of the Kaikoura population. However, in its favour is the point that the Mt Somers locality (near the coal mine incline) provides a rocky habitat with numerous deep crevices. The Mt Somers site is highly modified by fire and exotic invaders including mammalian predators of weta. Rediscovery of the Mt Somers weta is a high priority challenge for insect conservationists.

"Deinacrida SPMOV." WATT, 1980

For the next mystery giant weta we turn to a report of a DSIR expedition to Dart Hut which took place in February 1980 (Watt, 1980): "A giant weta *Deinacrida* sp.nov. (Stenopehnatidae) [was] frequent above 1800 m". These were found on Mt Ansted, Mt Tyndall, Headlong Peak, and above the Rees Saddle. We visited the Rees Saddle site in January 1993 to obtain live specimens for genetic analysis. Although this weta looked quite remarkable with its vivid black and white banding on the abdominal tergites, all its other characters suggest that it is a colour variant of the widespread alpine scree weta, *D. connectens.* Different populations of this species display considerable colour variation of the tergites (Field, 1980; Ramsay, 1961; Gibbs and Richards, 1991) but this outlier population is the most extreme colour variant so far recorded. Allozyme analysis has not been completed but the karyotype of the male (2n = 19) places it in the same group as the western population at Mueller Hut, Mt Cook, but distinct from those in the eastern Otago mountains where 2n = 17 (Gibbs and Richards, 1991). A specimen of *D. connectens* (NZAC) from the Takitimu Ranges in Southland (in 1955) possibly shows the same melanic colour patter (Ramsay, 1961) but it is difficult to judge from a dried pinned specimen.

STATUS OF THE NAMED SPECIES

We have been able to obtain at least some live material of all but one of the *Deinacrida* species (*D. carinata* from islands in Foveaux Strait) for allozyme or karyotype analysis. In general these data have confirmed the present taxonomy but some comments are necessary on the species groups which involve offshore island populations. Many of New Zealand's islands support species of weta, often more than one. As well as indicating previous land connections, these island populations frequently show some degree of divergence from their nearest relatives on the mainland. In three cases, the island population has been regarded as a distinct species. The tree weta of Stephens Island *(Hemideina crassicruris)* is considered distinct at species level from the tree weta on both mainland sides of Cook Strait and on other islands (*H. crassidens*) in the revision of Salmon, 1950. The genetic data do not show any distinction between these species although other characteristics, such as colour, size, and behaviour can be differentiated (Barrett, 1991).

The other two cases involve species of *Deinacrida*. In the north, *D. fallai* is an island population from the Poor Knights Islands while *D. heteracantha,* although formerly on the Northland mainland prior to about 1900, is now confined to Little Barrier Island. Two individuals each of *D. fallai* and *D. heteracantha* were compared with three "Mahoenui weta". From 20 loci, a unique allele was found at one locus in *fallai;* another unique allele at a different locus in *heteracantha;* and unique alleles at two further loci in "Mahoenui weta". (i.e. two fixed differences between the two island populations and three fixed differences between each island and the Mahoenui population) This is marginal evidence to make taxonomic decisions but indicates the genetic separation is greater between "Mahoenui weta" and the island species than between the two island populations. Chromosome preparations from *D. fallai* and D. "Mahoenui" showed the same karyotype. The current species status is thus supported but without much confidence.

The other species-group of giant weta with mainland and island populations is the *D. rugosa-D. parva* combination. The former occurs naturally on Stephens Is., Trio Is., and Mana Is. (previously also on Kapiti Is and at Wanganui on the North Island) while the latter is known from the Kaikoura district of the South Island. Sample size for our genetic data is minimal but is worthy of comment (one from each of Mana Is. and Kaikoura, two from Stephens Is.). Allozyme analysis detected only three variable loci. One fixed difference was found between Mana and Stephens Island populations in 19 loci but this locus could not be scored for *D. parva.* Of the 18 loci suitable for analysis in *D. parva* only one was unique. With such low protein variation these small samples do not give a very accurate estimate of genetic distance but clearly this distance is small. The karyotypes of the four individuals from these three localities share a number of common distinctive features that set them apart from other *Deinacrida* species but each individual had a different diploid number of chromosomes and males had an even diploid number suggesting that the island populations may possess B chromosomes in their complement. Further specimens are needed to interpret the significance of this information. Morphometric data show that *D. parva* is a smaller species but otherwise virtually identical with *D. rugosa* (Meads & Notman, 1991, 1992). They differ also in their ability to be bred successfully in captivity (Meads &

Notman, 1992) and therefore presumably in aspects of their ecology and behaviour in the wild.

The differences we have found between island populations and their nearest mainland relatives are compatible with species-level distinctions but also with the view of island isolates of the same species. Further studies are required of these interesting situations. To complete the picture, it is necessary to include *D carinata* in the genetic survey when material becomes available. From its morphology and especially the nature of the stridulatory file, it seems to belong in the South Island species-group which includes *D. connectens* and the diminutive subalpine giant weta from Northwest Nelson, *D. tibiospina.*

In summary, we consider the genus *Deinacrida,* as currently defined, to comprise ten species: three with informal names and seven formal species. However, we suggest that two sets of island species require further scrutiny. We realise that if such studies reduce the list of formal species by synonymy, some conservation managers may regard this as a downgrading of conservation status. The suggested research is certainly justifiable scientifically. We would like to think that further study of these intriguing island-mainland population differences should increase the conservation value of all populations of our remarkable giant weta.

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THE CONSERVATION STATUS OF THE CHATHAM ISLANDS PROTECTED BEETLE SPECIES

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Twenty-six species of invertebrates were given legal protection by being listed on the Seventh Schedule of the Wildlife Amendment Act 1980. Three of these were large beetles, known only from the Chatham Islands, and thought to be rare or endangered, principally due to habitat modification and predation. These species are:

Amychus candezei Pascoe (Elateridae) - Chatham Islands click beetle

Hadramphus spinipennis Broun (Curculionidae) - coxella weevil

Xylotoles costatus Pascoe (Cerambycidae) - Pitt Island longhorn

When placed on the Schedule very little was known about these beetles except that they were apparently rare or endangered and that the Coxella weevil fed, as larvae and adults, on Coxella, *Aciphylla dieffenbachh.* Increased knowledge of their distribution, status and biology was identified as a priority by the Department of Conservation (Hughey, 1990). This led to DOC funding to the Department of Entomology at Lincoln University for two visits to the Chatham Islands and associated research. Research objectives were:

- to establish the former distribution of the species by reference to museum collections.
- to locate populations of the three species in the field, to assess their conservation status, devise simple methods of population monitoring, and advise on options for management.

RESULTS

Amychus candezei Pascoe

All recent records of *A. candezei* are from the outlying islands of the Chathams group; Rangitira, Mangere and The Sisters Islands. The record from Mangere Island is based on two specimens found by us in pitfall traps in Robin Bush. The species has never been recorded from Pitt Island, but formerly occurred on Chatham Island.

Five specimens were collected from Hapupu, Chatham Island as recently as 1967, but careful collecting there in 1992, using techniques that had been successful on Rangitira, failed to turn up any specimens. Communication with one of the 1967 collectors revealed that the specimens found had been collected under large, very rotten logs, still surviving in an otherwise grazed out habitat (Townsend pers. comm). Perhaps the fencing at Hapupu came too late to preserve these last remaining favoured sites, or perhaps the wekas, very numerous in the area in 1992, finished off the last *Amychus*. Night collecting at Taiko Camp might be worth investigating as the habitat there appears more suitable.

On the outlying islands, competent investigators who have looked for *Amychus* have apparently always found it. Our assessment is that it is not really threatened, so long as the three populations, or four, if Big Sister and Mid Sister are regarded as separate, remain viable. Some concern has been expressed about the continued survival of woody vegetation on the Sisters Islands due to recent drought and the pressure of seabirds. The Sisters populations should be checked. Also has anyone ever looked for *Amychus* on Star Keys? If snipe can survive there *Amychus* may also be present.

Monitoring a sparsely distributed, flightless, insect poses some problems. Our best solution, that is non-invasive, is night searching of tree trunks with a spotlight. On Rangitira we found an observer could regularly find 3-4 specimens in a two hour period, on an average night. On a "good" night an observer might see 8-10 in the same period. The main problem is we do not know, at this stage, what makes for a "good" night. Our only guide is that the same observer should see between one and two times as many specimens of *Dorcus capito* (Deyrolle), the large Chathams stag beetle. So, if numbers of stag beetles are being seen, but *Amychus* is not, it would suggest something is wrong. This rule of thumb seemed to work for four observers on Rangitira on each of three nights, but would need to be tested in other situations.

Hadramphus spinipennis Broun

This large *Aciphylla* feeding weevil was originally described from Pitt Island, but in recent years has only been found on Mangere and Rangitira. There are no positive records of it from Chatham Island or elsewhere, although its host plant *A. dieffenbachii* still survives in limited numbers on Pitt and Chatham Island. Unfortunately *A. dieffenbachii* is very susceptible to grazing, so it only survives in areas inaccessible to sheep.

Recent sightings of the coxella weevil on Rangitira have been from a patch of Aciphylla, growing below the summit cliffs. This area was not reached by our group in 1992, but a single specimen of the weevil was found at night on the trunk of a *Pseudopanax*, in the lower part of the Woolshed Bush. This record may be of some significance, apart from indicating the weevils are very mobile, its association with *Pseudopanax* may not be entirely fortuitous. There is another specimen, in the New Zealand Arthropod Collection, also from Rangitira, collected in 1970 on a *Pseudopanax* trunk at night. *Pseudopanax* belongs to the plant family Arahaceae, which also includes *Stilbocarpa*, the host plant of the Stewart Island/Snares Island species of *Hadramphus, H. stilbocarpae.* Araliaceae are thought to be very closely related to Apiaceae, the family to which *Aciphylla* belongs, so it is possible that *Pseudopanax* may form an acceptable alternate host, at least for adult *Hadramphus*.

The main population of *H. spinipennis* is on Mangere, where the species can now be found wherever *Aciphylla* grows on the island. Previously (Young, 1989) the coxella weevil could not be found on the *Aciphylla* growing on the south western end of the island or below

Robin Bush. Weevils appeared to be numerous, with larval and adult feeding damage clearly apparent in all patches of *Aciphylla*. Adult beetles and occasional larvae were found in most areas during the day and adults could be seen resting at the bases of plants. Weevils could easily be counted and observed at night, when they were plentiful on *Aciphylla* flower heads. Night observation is the best way of monitoring their presence and distribution.

Xylotoles costatus Pascoe

This species remains enigmatic. All older records, where they have adequate locality information, are from Pitt Island. Extensive collecting on Pitt Island by ourselves, and former DSIR Entomology Division personnel, over the last 25-30 years have failed to find the Pitt Island longhorn. This has included specific searches for the species and the use of specialised longhorn collecting techniques, such as branch traps. The related *X. traversii* can readily be collected in substantial numbers using these techniques. In 1987, however, John Dugdale (then with DSIR Entomology Division) collected one specimen, on Rangitira, beating a dead ngaio branch caught up in a tangle of *Muehlenbeckia*. We also found one specimen at night, walking up a *Coprosma chathamica* tree which was growing next to the remains of the old woolshed in Woolshed Bush on Rangitira.

Thus only two specimens of this species have been found in the last 70 years, both on Rangitira and both in situations that indicate very little about the habitat requirements of the species.

Our feeling is that if *X. costatus* survives on Pitt Island, it must do so in very low numbers, or in a specialised habitat that we have yet to stumble on. It obviously still survives on Rangitira, but even here the available evidence suggests a very sparse population.

CONCLUSION

The present conservation status of the three listed Chatham Islands beetles varies markedly between species. *Amychus candezei* does not appear to be seriously threatened, so long as the off shore islands remain rodent free. It is evidently present as several distinct populations within the Chathams group, including an apparently substantial population on Rangitira. Efforts should be taken to assess The Sisters Islands populations, and to check for its presence on Star Keys and in the bushed areas of the Southern Tablelands on Chatham Island. Further refinement of monitoring techniques might be useful.

Hadramphus spinipennis remains vulnerable. There are only two known populations, although one appears quite large, and both are vulnerable to possible rodent establishment. A priority should be to establish a further independent population. Additional work needs to be done to investigate the possible use by the weevils of *Pseudopanax* as a secondary host plant. Key questions about the impact of *H. spinipennis* on its host, *A. dieffenbachii*, remain unanswered. Young (1989) reports the complete disappearance of mapped patches of *A. dieffenbachii* on Mangere. *A. dieffenbachii* is itself a listed endangered plant (Wilson & Given, 1989). There is indirect evidence that the coxella weevil may be implicated in these disappearances. Another question that will need to be addressed in the longer term is the effect of the planting programmes on Mangere on the *Aciphylla* population and hence on the coxella weevil.

The situation with *Xylotoles costatus* remains critical. The only recent information on the species is of two specimens from Rangitira where it evidently persists in low numbers. A high priority for research must be to identify its habitat accurately.

Also of critical concern must be another Pitt Island weevil, *Thotmus halli* Broun, known from a single teneral specimen, collected in 1906/1908, and probably associated with sandy beaches. It is so rare and little known that it was apparently unknown to the compilers of Schedule 7.

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REARING ENDANGERED SPECIES

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The Horticultural Research Insect Rearing Facility at Mt Albert, Auckland, has many years' experience rearing insects for a range of research programmes.

Our specialized rearing facilities are unique in Australasia, incorporating 12 controlled environment rooms where temperature, lighting and humidity can be varied; dedicated rearing laboratories and glasshouses. This, combined with a small team of experienced and competent staff ensures quality insect production.

In past years insect rearing has provided insects to feed endangered birds and wildlife. More recently techniques have been developed for rearing endangered insects especially weta.

Four species of weta have been reared: the Australian winged weta, *Pterapotrachus* sp.; the Mahoenui giant weta, *Deinacrida* sp.; the Hokianga tusked weta, *Hemiandrus montrosus* and *Nemiandrus* sp., a small *Hemiandrus* species from Middle Island. It is hoped specimens of the Middle Island tusked weta will be obtained soon.

THE AUSTRALIAN WINGED WETA

The Australian winged weta has recently become established in Pukekohe and probably in several other locations around Auckland. Five adults were collected from Pukekohe in January 1991 and were reared through two generations. The colony has been discontinued.

THE MAHOENUI GIANT WETA

In January 1992 1 male and 4 females of the Mahoenui giant weta were received. They have been fed on a variety of plants and insects. The wetas were kept mostly at ambient lab conditions, but the eggs were given a two and a half month chilling period at 10°C. The first eggs started to hatch on 3 May and to date (7 May) we have 19 juveniles.

THE HOKIANGA TUSKED WETA

In April 1992 we received one male and three females of the Hokianga tusked weta. They were offered a variety of insects and plant material and survived for several months. Further specimens were obtained in December 1992 and are being kept in an insectary at outside ambient temperatures. As at 1 May 1993 at least two of these were still alive. They appear to be very susceptible to disturbance and therefore are left undisturbed as much as possible.

Hemiandrus sp.

In October 1992 ten specimens of this small ground weta were collected from Middle Island in the Mercury group. They are being maintained in an insectary at ambient outside temperatures. This species is being used to develop rearing techniques which may be applicable to rearing the threatened Middle Island tusked weta.

THE MIDDLE ISLAND TUSKED WETA

The Middle Island tusked weta is a threatened species occurring only on Middle Island in the Mercury Group. The population suffers intense but natural predation from abundant lizards, tuatara, giant centipedes and probably other vertebrate and invertebrate predators. Further, the area of suitable habitat is threatened by slope instability and the population is at risk from possible accidental rodent invasion and colonisation by other detrimental alien species such as wasps. To minimise the threat of extinction, new populations should be established on neighbouring islands as they become free of introduced mammals. As the population is not thought to be big enough to enable adequate numbers of specimens to be directly transferred to other islands without putting its survival at risk, it will be necessary to breed wetas in captivity for such introductions. Successful captive breeding will probably depend on creating a close simulation of the natural breeding conditions in captivity.

To help achieve this a data logger was set up on Middle Island to record air and soil temperatures.

THE PERSISTENCE OF SODIUM MONOFLUOROACETATE (1080) AND BRODIFACOUM IN INVERTEBRATES

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Aerial application of vertebrate pesticides is common practice in New Zealand to protect native fauna and flora from introduced mammal species. Sodium monofluoroacetate (1080) has been used in cereal and carrot baits to control possums for many years. More recently, brodifacoum cereal baits (Talon) have been aerially sown over islands, as part of successful rodent eradication campaigns. Concerns have been expressed about the fate and impact of brodifacoum and 1080 after aerial application of toxic bait.

One particular concern is the potential contamination of invertebrates. It has been suggested that if there is significant long-term contamination of invertebrates, insectivorous birds will be put at risk of poisoning beyond the period that toxic baits are present on the ground. In response to these concerns, laboratory and field studies have been initiated at Manaaki Whenua-Landcare Research, Christchurch, and at Puketi Forest, Coppermine Island, and Red Mercury Island.

LABORATORY STUDIES - PERSISTENCE IN WETA

Individual tree weta (Orthoptera, Stenopelmatidae) were dosed orally in the laboratory with sub-lethal doses (15 m g/g) of 1080 or brodifacoum using a micro-syringe (Sutherland *et al.* 1982). Two weta were then killed after dosing at each point in a time series.

Preliminary results indicated that most 1080 is eliminated from weta within 1 week of dosing (Table 1). At this stage, we have analysed only one weta at each time point. Further 1080 analysis and analysis of those weta dosed with brodifacoum are scheduled for August and September 1993.

TABLE 1. Sodium monofluoroacetate concentrations in individual tree weta after oral dosing with 15 mg/g

Time after dosing h = hours d = days	1 h	4h	12h	24h	2d	4d	6d	10d	14d
Concentration	5.5	5.8	5.8	5.0	2.8	4.5	0.2	0.033	0.038

FIELD TRIALS - PERSISTENCE IN LIVING INVERTEBRATES

Invertebrates were collected live for 1080-residue analysis from six sampling stations in Puketi Forest, once before and on seven occasions after application of cereal possum baits containing 0.08% 1080, sown at 5 kg/ha. The invertebrates comprised nine orders spanning five classes (Table 2). Except for the insects, animals from each sampling station were analysed by class. Insects were analysed at the order or family level. The numbers of some species varied for each sample, reflecting the difficulty in collecting some species. For example, the average sample number for tree weta and cockroaches was six, but for cave weta it was three.

TABLE 2. Invertebrates analysed

Common name	Class	Order	Family/Genus
Spiders	Arachnida	Araneae	Araneidae, Lycosidae
Centipedes	Chilopoda	Scolophendromorpha/ Geophilomoipha	Cormocephalus
Millipedes	Diplopoda	Oniscomorpha/Juliaforma	
Earthworms	Oligochaeta	Lumbricina	
Cave weta	Insecta	Orthoptera	Rhaphidophoridae
Tree weta	Insecta	Orthoptera	Stenopelmatidae
Black beetles	Insecta	Coleoptera	Carabidae, Lucanidae
Cockroaches	Insecta	Blattodea	Blattoidea

No residues of 1080 were found in spiders, beetles, millipedes, centipedes, or earthworms in any sample. Residues of 1080 were present in some cave and tree weta, and in cockroaches for up to 3 weeks after the baits had been sown (Table 3). The highest concentrations detected in cockroaches and cave weta were 2 and 4 mg/g, respectively. The highest residue concentrations of 1080 occurred in tree weta (46 mg/g) at one sampling station two days after poisoning (Table 3).

A similar range of invertebrates has been collected on Coppermine Island following aerial application of brodifacoum baits and we will be analysing these samples shortly.

PRELIMINARY CONCLUSIONS

Our field and laboratory results show that 1080 is taken up by some of the terrestrial invertebrate groups monitored. However, in these groups, 1080 is present in the tissues for only short periods. The relatively low levels found indicate that 1080 is not retained. This suggests that there will be little risk of significant amounts of 1080 entering the food chain to pass from invertebrates to birds. We have also shown that 1080 is rapidly eliminated from mammals (Eason *et al.*, in press). However, brodifacoum can persist in mammalian liver for several months (Lass *et al.* 1983), and may persist in invertebrate tissue.

TABLE 3. **Mean sodium monofluoroacetate concentration (mg/g) in bush weta, cave weta, and cockroaches after aerial sowing of 1080 baits (range in brackets)**

Time after sowing	Mean 1080 concentration (mg/g)		
	Tree wetas	Cave wetas	Cockroaches
Before sowing	0.0 (0-0)	0.0 (0-0)	0.0 (0-0)
2 days	12.0 (046.0)	0.0 (0.0-0.0)	1.0 (0.17-1.83)
1 week	1.4 (0-0.4)	2.1 (1.14.1)	0.8 (0.06-2.14)
2 weeks	1.1 (04.5)	1.2 (0-2.5)	0.6 (0.07-1.49)
3 weeks	0.8 (04.5)	0.0 (0-0)	0.02 (0-9.11)
4 weeks	0.2 (0-1.2)	0.0	0.0
8 weeks	0.0 (0-0.01)	0.0	0.0
16 weeks	0.0	NS	0.0 (0-0)

We will continue to monitor the fate of brodifacoum and 1080, including further monitoring of residues in invertebrates and waterways after aerial sowing of bait, particularly when different bait types or concentrations of 1080 or brodifacoum are used. We also plan to evaluate the toxicity of brodifacoum and 1080 to invertebrate species, the behaviour of invertebrates such as weta towards baits, and their behaviour after eating baits containing brodifacoum or 1080. Separate studies on the impacts of brodifacoum (E. Spurr, pers. comm.) and 1080 (M. Meads and E. Spurr, pers. comm.) on invertebrates at the population level are currently in progress.

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Appendix 1

GUIDELINES FOR COLLECTING

The collecting of insects is an important activity, essential to the pursuit of entomology. Whilst wishing to encourage a strong enthusiasm for entomology, we must point out that there are responsibilities which anyone collecting insects or other animals should keep in mind - the importance of preserving habitats and ecosystems, the protection and maintenance of populations of rare or endangered species together with their habitats, and the minimum impact code of the Nature Conservation Council. Irresponsible collecting can have a detrimental effect on insect populations and on the environment, e.g. the capture and removal of important predators.

The following remarks and code do not apply to pest species. Conservation should always be kept in mind. In general, rare insects should be collected only for scientific study and not just to add another specimen or species to a collection. No specimens should be collected from National Parks or Reserves without permission. As the activities of collectors may have a detrimental effect on the fauna and habitat, we suggest that collectors abide by the following code, which is a modification of *A code for insect collecting* prepared by the Joint Committee for the Conservation of British Insects. This committee was established in 1968 by the Royal Entomological Society of London. (See also, Nature Conservation Council Information Leaflet 20, *Collection code for New Zealand invertebrates,* 1979. Techniques for studying and collecting insects are described in a number of books listed in the literature section of this guide (p 37 to 48), especially those in the "Techniques" category.)

Note: Authorities for permits and for advice have changed since the original publication of this code. Please get in touch with your local government authorities for details on permits; other information can be obtained from Landcare Research, Mt Albert, Auckland, or from the Museum of New Zealand, Wellington.

A CODE FOR INSECT COLLECTING

1. Collecting - General

1.1 Collect specimens only when required for a justifiable purpose (on conservation and scientific grounds), and then no more than the minimum number required for its fulfilment.

1.2 Examine readily-identified insects alive, and release where captured unless voucher specimens are required.

1.3 Do not collect the same species in numbers year after year from the same locality.

1.4 Never collect all leaf-mines, galls, seed heads, and similar materials, that can be found; leave as many as possible for the population to recover.

1.5 Keep damage to, and interference with, the environment to a minimum (see 5 below).

1.6 Consider photography as an alternative to collecting.

1.7 Do not collect specimens for exchange or disposal to other collectors.
1.8 Do not collect insects for commercial purposes. They should be reared.
1.9 Never collect in any reserve without a permit.

2. Collecting - Rare and Endangered Species

2.1 Specimens on the list of protected species of the first schedule of the Wildlife Amendment Act 1980 should never be collected without a permit.
2.2 Specimens of distinct local forms or varieties should be collected with restraint.
2.3 Collectors should attempt to break new ground rather than collect a local or rare species from a well known or perhaps overworked locality.
2.4 Previously unknown localities for rare species should be brought to the attention of Systematics Section, Entomology Division, DSIR, Private Bag, Auckland, which undertakes to inform other organisations, as appropriate, in the interests of conservation.
2.5 Specimens of rare or endangered species accidentally collected or found dead should be deposited in a national collection - the New Zealand Arthropod Collection, at Entomology Division, DSM Auckland, or that of the National Museum, Wellington - and not retained in a private collection. It is illegal to possess specimens of absolutely protected species without a permit.

3. Collecting - Lights and Light-traps

3.1 Live trapping is to be preferred.
3.2 The "catch" at a light or light-trap should not be killed casually for subsequent examination.
3.3 After examination of the catch the insects should be kept in cool, shady conditions and then released away from the trap site during darkness. If this is not possible the insects should be released in long grass or other cover and not on lawns or bare surfaces.
3.4 If a trap is found to be depleting rare species, it should be re-sited.
3.5 Traps and lights should be sited with care so as not to annoy neighbours or cause disruption.

4. Collecting - Permission and Conditions

4.1 Seek permission from the owner or occupier of private land, or from the administering authority as in the case of National Parks, Reserves, Forest Service lands, and Wildlife Refuges.
4.2 Always comply with any conditions laid down by the authority granting permission to collect.
4.3 When collecting on reserves or sites of known interest to conservationists, supply a list of species collected to the appropriate authority.

5. Collecting - Damage to Environment

5.1 Do as little damage to the environment as possible; be careful of nesting birds and of vegetation, especially rare plants.

5.2 When beating, never shake trees and bushes so that foliage and twigs are removed. A sharp jarring of the branches is both less damaging and more effective.

5.3 Bark and other material removed from dead timber should be replaced as far as possible. Not all dead wood or bracket fungi in a locality should be worked.

5.4 Overturned stones and logs should be replaced in their original positions.

5.5 Exercise particular care when searching for rare species, e.g.,by searching for larvae rather than by beating for them.

6. Rearing

6.1 Rearing from an inseminated female or a pair in captivity is preferable to collecting a series of specimens in the field.

6.2 Never collect more larvae or other stages than can be supported by the available supply of food-plants.

6.3 Unwanted insects that have been reared should be released in the original locality, not just anywhere, in order to increase their chances of survival and to avoid further alteration of natural ecosystems.

6.4 Before attempting to establish new populations or "reinforce" existing ones, please consult the Entomological Society of New Zealand, C/- Entomology Division, DSIR, Private Bag, Auckland. It is illegal to introduce animals into reserves without permission from the appropriate authority.

6.5 Advice on rearing species is available from Rearing Section of Entomology Division, DSM Auckland.

Appendix 2

PARTIAL REPORT FROM WORKSHOP GROUPS

1. CURRENT MANAGEMENT - SUCCESS OR FAILURE? LESSONS FOR THE FUTURE

Spokesperson - Greg Sherley

Key issues:
- some successes and some failures
- need public support
- must be nationally coordinated
- problems with monitoring low density populations
- skills vary nationally
- lack of life history knowledge
- taxonomic impediment
- invasive damage to habitat
- better communication needed between relevant parties
- conflict with vertebrate conservation (island transfers)
- continuity of funding
- lack of input/control in South Island high country
- seasonality of fauna
- land status (owners perception changes over time)
- do nothing option
- captive rearing potential
- status of land - problems with covenants
- 1080 and non-target invertebrates.

The future:
- networking of existing knowledge (better communication)
- local endemics given priority for protection in situ
- treat mainland sites as "islands", relevant for invertebrates
- advocacy of new technology to assist in protection.

2. ARE THE DOC CRITERIA (MOLLOY & DAVIS 1992) FOR ASSESSING THREATENED INVERTEBRATES APPROPRIATE?

Spokesperson - Brent Emerson

Seventeen criteria, assessed within five different categories, indicate threatened species:
- taxonomic distinctness (lx)
- status of species (6x)
- threats facing species (5x)
- vulnerability of species (3x)
- human values (2x)

Other characteristics of the system are:

* a ranking system
* species gets a score of 1-5 for each criteria
* identifies those threatened species which should be urgently assessed.

It is a first step. Supposed to identify high risk groups. Then other considerations taken into account, e.g., financial, political, technical.

Key issues:

- qualitative index from qualitative criteria
- linear scale from non-linear data
- invertebrate state of knowledge means they grossly over-stated or under-stated
- lack of life history knowledge is an impediment
- taxonomic distinctiveness is not easy to answer
- captive rearing criteria not appropriate
- cultural values inappropriate considering size, etc.

Recommendation: Overall the criteria developed by Molloy and Davis (1992) are a good start, but realistically invertebrates should be dealt with separately by a specialist group set up to assess them.

3. HOW DO WE GET THE INSECT LISTS TO WHICH WE CAN APPLY CRITERIA?

Spokesperson - John Dugdale

Key issue:
Where is DOC going to get invertebrate information, especially in relation to seventh schedule of the Wildlife Act 1980

Four areas need to be considered:

1 **What sort of annotated lists does DOC want?**

a. A lot ofthreatened/at risk species (relevant to IUCN categories and criteria).
b. Local endemics (conservancy/ecological districts).
c. Local collections/expertise and literature/records resources.
d. Biogeographic/distributional nodes/hotspots.
e. Higher taxon endemics and where.
f. Distribution of the large, the flightless, or bizarre.

2 Who can supply them? Note - although the schedule "tolerates" informal names, there is a high degree of non-acceptance of them by the decision makers (see constraints).

Landcare Research, MAF Qual, museums, relevant universities would send DOC up-dateable capability statements. These need not be formal, nor - for universities - might they be comprehensive or compulsory.

Entomological Society of NZ might act as a coordinator/contractor for this resource, if the society considers this appropriate.

3 How feasible are the lists mentioned in section 1?

List la: Feasible with current knowledge. Disagreements are inevitable, but likely consensus on most threatened groups/habitats/species.

Lists lb and d: Not all regions, not all groups evenly known. Again, will highlight gaps/problem areas.

List lc: Feasible, no problems.

Lists le and f Feasible, and again identifies gaps.

Two values of this exercise: lets DOC know who knows what/where, and defines areas/subjects for future study (DOC writes its own research programme).

4 What problems could arise?

Intellectual property - could have problems here, as not everyone believes natural history knowledge is free. CRIs could be sticky, but see note under 2.

Who pays for the time to devise/compile these annotated lists?

Databases - not all compatible, some simple, some, like TKCs, complex and covering as yet a comparatively small subset; however, a major FRST thrust to develop these is under way.

Need an update (annual) mechanism/route to/in DOC-HO-divisions/regional or to all? Has DOC got requisite regional staff flexibility to look after these?

Other issues raised: Possibility of arriving at - protection of all indigenous/endemic taxa in New Zealand with removal of protection of some in designated areas, e.g., *Orocrambus flexuosellus* - does it warrant protection?

4. IS CURRENT INVERTEBRATE MONITORING AND RESEARCH USEFUL TO CURRENT MANAGEMENT?

Spokesperson - Colin Miskelly

Main agencies:

Landcare Research	Money driven
FRI	FORST/MORST Research Agenda
Ag Research	Strategic Research
Universities	Staff free to pursue own research interests but time decreasing. Students take staff and DOC direction but limited resources and time.

Department of Conservation	Has research agenda. Lacks staff with invertebrate knowledge. Has local knowledge/local priorities
Private Contractors	Money driven. Cooperation with DOC. Can apply for FORST funding
Local enthusiasts -retired - amateurs	Local knowledge. Productive. Often unknown to us.

Our effectiveness:

- Our research priorities are not well publicised
- Patchy entomological coverage and not utilising local knowledge that is often available
- Some successes to date
- Better communication nationwide between all parties would increase the use of monitoring and research to management.

5. SHOULD THE EMPHASIS BE ON PROCESSES, HABITATS OR SPECIES?

Spokesperson - Craig Miller

Key issues:

- Species covered by legislation
- ecological reality; species do not exist in isolation
- political reality that large and colourful have higher profile
- cost effectiveness of species approach
- maintain biodiversity (IUCN - Rio de Janeiro)
- protect fauna for intrinsic value and future generations (Conservation Act 1987)
- conservation of change or status
- maximum biodiversity - ecosystems
- philosophically should protect and recognise natural processes.

6. RECOVERY PLANS FOR SPECIES OR GROUPS OF SPECIES - PLACE FOR AND IMPORTANCE

Spokesperson - Bruce McKinlay

Key issues:

- sort out the audience
- clear purpose
- ensure a flexibility in the plan to take account of changing circumstances
- single species or groups of related taxa
- expand into habitats and natural processes
- considered very important for managers and advocacy role.

7. HOW CAN OUR MANAGEMENT OF INVERTEBRATES BE USED TO FURTHER THE ADVOCACY OF INVERTEBRATES?

Spokesperson - Olwyn Green

Key issues:

- acknowledge that we could do better to raise the profile of invertebrates
- ID possible targets (right time/right place
  - within DOC
  - landowners/DOC neighbours
  - public - especially children
- each project proposal has advocacy budget included - time/photography
- tell your story as you go - report on progress regularly, particularly special finds
- recognise opportunities
  - Conservation Week
  - Weetbix cards, etc.
- apply lessons learned elsewhere to invertebrates
- build up resource library
  - glossy photos
  - enlargements
  - slides
  - roadshows
- include invertebrates in track guide notes, interpretation boards, displays in zoos - heighten awareness
- start now.

Appendix 3

SOME RECOMMENDATIONS

The following five recommendations are the direct result of the seven discussion groups whose notes were presented in Appendix 2. The recommendations concern the topic **Setting Priorities for Conservation Management**, and the groups' spokesperson was Brian Patrick.

1. **That the Department of Conservation take the opportunity when managing terrestrial invertebrates to raise the profile of the target species/habitat/and natural process involved, in an effective way to the public.**

Key points

- identify audience
- allocate appropriate funding at early stage, e.g., when proposal accepted by science provider
- build on existing local enthusiasm/knowledge
- update regularly (maintain momentum)
- change legislation to protect all species.

2. **That the Department of Conservation fund the Entomological Society of New Zealand to coordinate a prioritised list of threatened, local and conspicuous New Zealand terrestrial invertebrates and key habitats for management.**

Key points

- require effective communication between all agencies and individuals:
- undescribed taxa not ideal but can be included
- committee of appropriate members
- revamp criteria to ensure relevance to invertebrates
- identify gaps in knowledge also.

3. **That the Department of Conservation consider expanding coverage of recovery plans to include ecosystems in addition to species or related taxa.**

Key points

- must formulate flexibility into plans
- must be user of audience for plans.

4. **In setting priorities for management of native terrestrial invertebrates, the Department takes full account of the natural processes and habitats of which the target taxon is a vital part, and eventually shift the emphasis from species management to processes where possible and appropriate.**

Key points

- legislation and recovery plans based on species at present
- recognition that style species may be useful for advocacy
- management objectives are important - are we managing for stasis or change.

5. **That an effective biosystematic and biogeographic programme funded by FORST underpins all the above objectives.**

Key points

- present taxonomic impediment
- curation and biosystematics related
- DOC has role to play in collecting material, data storage and retrieval
- DOC can help set biosystematics priorities.

Chris Green suggested an addition to recommendation "2": "That all the collection data for the species on the list generated be added as a priority to a collection database which is available to the Department of Conservation."

Key points

- existing collections hold valuable data on specimen labels, etc. (habitat type, numbers, method of collection, distribution, abundance, when, who collected, etc).

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