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Managing New Zealand's biodiversity: Identifying the priorities and widening the options

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ABSTRACT

Six priorities are identified for the future management of New Zealand's biological diversity: developing a broader understanding of what the nation's biodiversity includes, involving a wider sector of society in protecting biodiversity, adopting a genuine ecosystem approach to its management, intensifying the effort to control invasive species, increasing the rigour of restoration programmes, and changing attitudes towards use of scientific research in solving biodiversity problems. Opportunities to increase options within these priorities are discussed.

1. INTRODUCTION

There is a degree of arrogance in the title of this talk. It seems to imply that we are capable of managing biological diversity, but there is not much evidence to support such a claim.

I have been asked to give a personal view of biodiversity. This means there will be a bias towards terrestrial environments. So far as my six priorities are concerned, they are simply those that I happen to have worried about most. There are others of course. There is no harm in acknowledging this subjective choice; many of the decisions we make in relation to biodiversity are, in the final analysis, value judgements. This is not to discount the value of scientific analysis in clarifying our options.

2. WHAT DOES THE NATION'S BIODIVERSITY INCLUDE?

Biodiversity includes indigenous species and those we have introduced. I will focus here on systems where indigenous species are dominant, but this is not to imply that biodiversity issues in agricultural, forestry and recreational land are not important. So what does our indigenous biodiversity include?

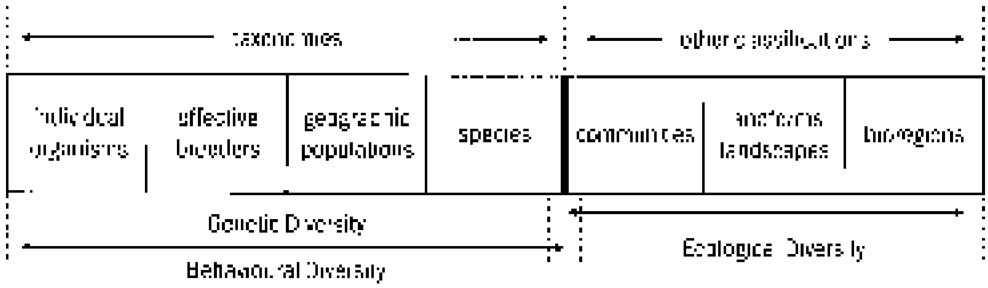

Figure 1. Components of biological diversity at levels above those of individual organisms (after Atkinson 1996a).

A spectrum diagram of the kind shown in Fig.1 can be helpful. In the centre are *species* which are usually made up of several *geographic populations.* Within each geographic population it is the number of *effective breeders* that determine the viability of that population. If that number drops to near zero, as happened with the black robin of the Chatham Islands, we become very concerned with *individuals*. In the robin's case the future of the species was for a short time dependent on a single female: 'Old Blue'.

To right of centre in Fig. 1 are *biotic communities,* aggregations of communities that can be associated with larger and larger areas of land. We have no adequate descriptive terms for these aggregations. However, the close relationship that often exists between landforms and communities (Atkinson 1994), a linkage effected through soil type, makes it useful to use differences between *landforms*, and the broader *landscapes* in which they stand, as a means of comparing differences between aggregations of communities. Moving to still larger areas we have *bioregions*; the ecological districts and regions recognised in New Zealand are examples (McEwen 1987). Ultimately we are thinking of differences between supraregional groupings, such as biotic provinces, realms and nations, and the contribution these differences make to global biodiversity.

Biodiversity is often described as genetic, ecological or taxonomic (Fig. 1). *Genetic diversity* is a fundamental property of living organisms, *ecological diversity* is a result of interactions between genetic diversity and the diversity of physical environments, and *taxonomic diversity* is largely a human construct - albeit an extremely useful one.

People relate to different parts of this spectrum of biological diversity in different ways. Some focus on species while others are more interested in particular individuals. Still others derive most satisfaction by relating to larger systems in which species or individuals are less important than the kind of place or environment where they are found. However when people talk of 'biodiversity' they are often thinking only about the number of species in a particular area, i.e. species richness. If we put too much emphasis on this we may discount the value of species-poor communities, such as those of extreme environments.

The number of species is nevertheless important because it governs the number of interactions taking place between species (Fig. 2). The more gentle curve

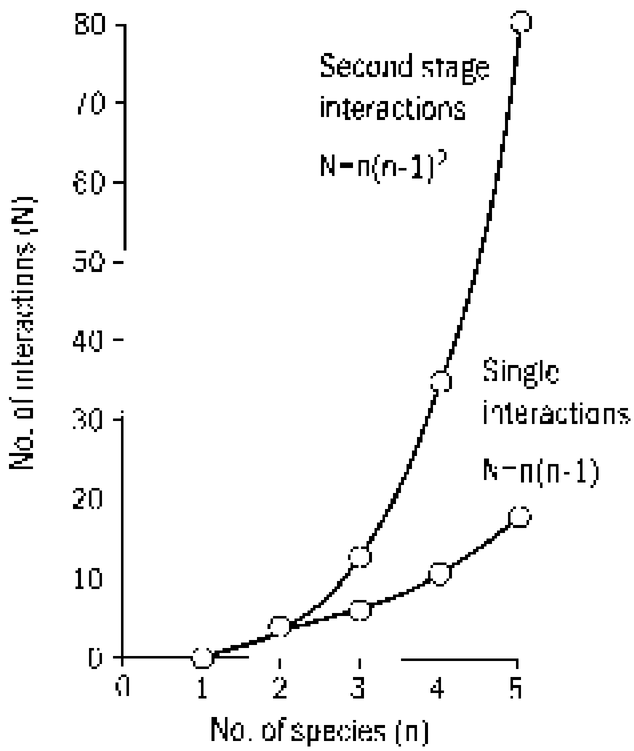

Figure 2. Relationships between number of species and potential number of single or second stage (2-step) interactions between species.

shows how the number of interactions between pairs of species increases steadily with the number of species present. The steep curve shows that when you add in interactions in which one species affects a second species through an intermediary species, a two-step interaction, then the total number of interactions increases very dramatically with increase in the number of species present.

If we were able to illustrate reality we would add in three and four-step interactions—and so on into networks of biological chain reactions—which are very difficult to comprehend in their entirety. My reason for bringing up this aspect of biodiversity is that, beyond their scientific interest, interactions between species are the very source of much of the fascination that people find in nature. Think of films we have seen and articles we have read on interactions between plant and animal species in tropical rain forest. Interactions should never be forgotten. When we lost the huia, we did not lose just a gangly black bird with a bent bill; we lost a whole suite of interactions between huia and other animals and plants in its environment that could have become a rich source of enjoyment and mystery for interested people. We must never think of 'biodiversity' as just a collection of species.

There is another aspect of biodiversity to remember. Before biodiversity became a buzz-word, diversity of organisms usually referred to the degree of biological divergence between species (or species groups) rather than the number of species in a particular area. We could have three species of native parrot, for example, living in the same habitat: red-crowned parakeet (kakariki), kaka, and kakapo. But the degree to which each of these species diverges in features and behaviour from other birds is not the same. The parakeet has a relatively narrow range of feeding behaviour; it is to some extent a kind of Aotearoan 'budgie'. Contrast this with the kaka, which probably has the widest variety of feeding habits of any New Zealand forest bird (cf. Atkinson & Millener 1991). Then consider the kakapo which has quite a narrow range of feeding behaviour; it has been fairly described as a 'large juice extractor'. But it has such a strange combination of other features (e.g. heaviest parrot in the world, nocturnal, flightless, only lek breeding parrot in the world, erratic timing of breeding attempts), that it stands apart from all other birds. Some differences between these parrots may be difficult to quantify, but it is easy to see why we do not treat these three species as of equal value whether from subjective or scientific viewpoints.

3. HOW CAN MORE PEOPLE BE INVOLVED IN PROTECTING AND RESTORING BIODIVERSITY?

Many people outside the membership of natural history and environmental societies support the protection of our indigenous biodiversity but do not become involved in such action in any significant way. 'Involve' is the key word and there is no better way to involve people than providing opportunities for them to actually *do* something on the ground or in the water.

There are many ways in which this can be achieved. A particularly good example is what has happened in recent years at Cheltenham Beach, on the North Shore of Auckland, opposite Rangitoto Island. In common with many sandy beaches throughout the country, this habitat originally supported extensive beds of shellfish, in this case tuangi and pipi. Increased harvesting in the 1980s, and possibly other factors as well, reduced tuangi density to about one adult per three square metres by 1991 (Gardner 1993). At that point Mary Gardner, a freelance biologist from Auckland, assisted by the North Shore branch of the Forest and Bird Protection Society, organised a group of local residents to begin scientific sampling of juvenile and adult shellfish on the beach. Some juveniles were found and this was the catalyst for the formation of the Cheltenham Beach Caretakers, who decided to request a ban on harvesting of all intertidal organisms. The idea gained strong support from local iwi as it fitted their concept of 'rahui'. Subsequently the idea gained support from MAF, thus giving the beach comprehensive protection, which was enforced through vigilance of local residents. The Caretakers have continued the semi-annual sampling and there is now solid evidence that a recovery of the shellfish beds is in progress. They enjoy the field sampling, despite poor weather at times, and know that they are contributing something of value. This kind of volunteer input, assisted by expertise from local scientists and focused on a local environmental problem, Gardner has called 'Neighbourhood Biology' (Gardner 1993, 1994). The concept has now been applied at other places in New Zealand and I believe it can be used as a model for involving people in many exciting programmes.

A second important initiative that has great potential for involving more people in caring for indigenous biodiversity is co-operative management between interested parties such as landowners, and organisations with appropriate expertise. Of particular importance here is the potential for co-operative management with iwi, relating to both sustainable harvesting of some species and protection of others. An example is the agreement reached between the Department of Conservation (DOC) and iwi concerning the future management of Stephens Island (Takapourewa) in Cook Strait. A potential example concerns Mayor (Tuhua) Island in the Bay of Plenty where the Maori owners, through their Trust Board, have asked DOC to remove pigs, cats and rats from the island, so it can be restored to a condition more like what it was before human influence.

In my view, there are at least two reasons why co-operative management does not happen more frequently. One is 'political correctness', where we cease to be honest with each other and thus destroy our ability to communicate effectively. We cannot deny that kiore (*Rattus exulans*) have had significant (sometimes devastating) effects on some species of indigenous animals and plants. Nor can we deny that, for many Maori, kiore are taonga. Both views are legitimate and based on facts. Pretending otherwise will not help us find ways of acknowledging and protecting the cultural status of kiore in some places, while removing this rat from other places where it threatens taonga of a different kind.

The second reason is that sometimes one party will deny or ignore the fact that the other has special knowledge that needs to be shared and applied by both parties. Progress with these difficulties requires more open discussion between parties to develop appreciation of what each has to offer.

4. HOW CAN WE DEVELOP A GENUINE ECOSYSTEM APPROACH TO MANAGING BIODIVERSITY?

Arthur Tansley coined the term 'ecosystem' in 1935, defining it as 'the whole *system* (in the sense of physics), including not only the organism-complex, but also the whole complex of physical factors forming what we call the environment of the biome—the habitat factors in the widest sense' (Tansley 1935). Thus a 'genuine ecosystem approach', as envisaged here, would attempt to manage several, if not many, plant and animal species in one area by understanding and then managing the linkages between water, soil, vegetation, animal life, and human activity.

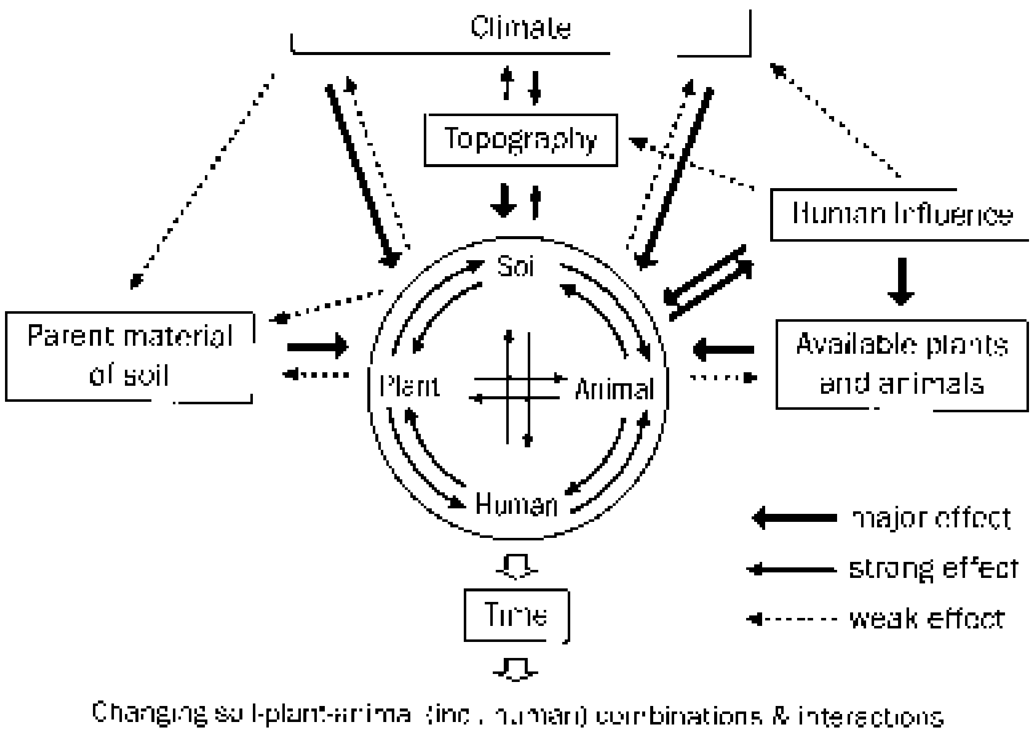

Figure 3. A factorial model of an ecosystem that separates the dependent soil-plant-animal-human part of the system from relatively independent controlling factors of the system. Human influence acts as both a dependent and independent variable. (Derived and extended from the work of Jenny 1941, 1958).

I use a factorial picture of an ecosystem to remind me of these linkages (Fig. 3). It owes a little to Hans Jenny's (1941, 1958) concept of independent factors of soil formation: climate, topography, soil parent material and available plants and animals (including humans) which control the soil-plant-animal systems we are trying to manage. The ecosystem processes connecting the various boxes act at very different scales, i.e. over very different distances. Runoff into a stream, for example, can only come from the catchment of that stream whereas seeds dispersed by wind or birds may come from far beyond the catchment. The effects of one group of processes are not necessarily balanced by the effects of another process group as this figure may seem to imply.

Adding the word 'ecosystem' to beech forest, subalpine scrub, wetland, etc., adds little, if anything, to the meaning of the vegetation type or habitat already specified. The real value of the term, that of emphasising *inter-connectedness* between physical and biological *processes* is lost.

Much of our landscape is a mosaic of grassland and forest of one kind or another. When we talk about grassland or forest ecosystems in a geographically specific rather than general sense, we imply that we have separate entities out there in the landscape; we draw attention away from the processes that connect these communities. Birds can disperse seeds from one 'ecosystem' to another but have no reason to respect our artificial boundaries. A Tb-ridden possum leaving the forest at night to feed in near-by pasture treats both 'ecosystems' as parts of its home range.

There is currently a move in New Zealand to classify ecosystems and perhaps even map them—a move driven I think by managers who would like to partition the country's biodiversity in the hope of making it more manageable. I do not wish to poke fun at the idea. Scientists put boundaries on ecosystems in order to study them; why then should not managers do the same in order to manage them?

In studying an ecosystem, temporary artificial boundaries enable us to measure inputs and outputs between that *part* of the system we are trying to understand and the surrounding environment. But if we then treat these artificial boundaries as management boundaries, they may prove useful for some kinds of process, but worthless for others.

So what are we to do? I think we should stop worrying about boundaries and focus attention on the *core areas* of the ecosystems we are trying to manage. What is it exactly that requires protection, restoration or some other kind of intervention? Is it a lowland mosaic of forest and pasture, a wetland or lake surrounded by hills, an estuary and its catchment, an island with all its connections to the marine environment? Having identified the core area of interest, what are the major processes affecting its future and which could we possibly expect to influence? We can still recognise management boundaries at places in the landscape where it is essential to change the kind or degree of intervention (management). But we should not call these 'ecosystem boundaries'. If they were real their positions would differ for every kind of process we identified, and in practical terms, would be unmappable.

Where does this leave the conservation manager? Ecosystem core areas could be identified by combining a geographic place name with a habitat descriptor, e.g.

Waipoua kauri forest, Kopoua peat dome, Lake Wairarapa wetlands, Taranaki mountain, Little Barrier (Hauturu) island, Mercury islands. Ideally, boundaries of a core area would coincide with the boundaries of legal protection, but this is often not possible. Where lakes and estuaries are concerned, it is especially important to recognise that if the core area does not include the whole catchment(s), then close liaison with the owners or authorities who control land-use in these catchments is essential to maintain an adequate management regime for the core area. The boundaries of some core areas we identify will *overlap*; the boundaries of ecosystems we have conceptualised within the same bioregion will *always* overlap.

What if a protected natural area is very small and isolated from other protected areas? The same principle applies, i.e. treat it as a small core area because it will be just as much if not more subject to processes going on in the surrounding landscape, whether the latter is a well defined catchment or an elevated site on a cliff.

As is often pointed out, the country's protected areas can be viewed as a collection of 'islands', in a 'sea' of contrasting land use. But in an ecosystem sense they are not islands. They are strongly influenced and connected to the surrounding unprotected landscape through fires, topdressing, herbicide spraying, cattle breaking fences, and people flowing in and out for all sorts of reasons. Conversely, a protected area has effects on the surrounding landscape: it can export native organisms or nutrients, pest animals or weeds into that land. Our management must continually take these various connecting processes into account. This means that we must raise the level of communication with surrounding landowners and their families so that they understand these connecting processes and, whenever possible, we must involve them in decisions concerning the management of our protected areas, large or small. This is what I mean by a 'genuine ecosystem approach'.

Who is to give effect to this approach? Everybody who has responsibilities or interests in the conservation of the nation's indigenous biological diversity can develop or promote a more inclusive, less compartmentalised, approach to managing our protected natural areas through attention to the larger landscapes in which they are placed.

I have been asked to comment on what I might think is the appropriate balance between species and ecosystem management. I think this argument wastes time. The two approaches are complementary. Rather than asking what the balance should be, we should spend more time clarifying the problem we are trying to right. Unless we adopt an ecosystem *process* approach (rather than just adding the word 'ecosystem' to any biotic community of interest) many of our protected areas will not remain viable.

What about species? If we wish to find a way of harvesting a native species in a sustainable manner we cannot get the answer by studying only its ecosystem. In the first instance we must focus on the biology of that species and subsequently on the implications of any proposed harvesting for other components of the ecosystem. Equally, with any threatened species, we must as far as possible understand the reasons for its decline before we can effect its recovery and, again, that requires an understanding of the biology of the species. At a later

TABLE 1. USE OF SPECIES-CENTRED AND ECOSYSTEM-CENTRED MANAGEMENT IN RECOVERY OF THREATENED SPECIES.

THREATENED SPECIES	KIND OF MANAGEMENT	
	SPECIES-CENTRED	ECOSYSTEM-CENTRED
Cook Strait giant weta	Translocation of some wetas from Mana Island to Maud Island	Eradication of mice from Mana Island: 1991
Black robin	Foster-parenting of robins to Chatham Island tomtits on Rangatira Island	Forest restoration on Mangere Island
Kakapo	Individual management of every bird in known population	Protection of whole island habitats against introductions of alien mammals; eradication of *Rattus exulans* when practical
Euphorbia glauca	Propagation from seed and cuttings	Control of problem weeds and browsing mammals in coastal habitat

stage we may need to use both species and ecosystem approaches to remove a species from the threatened category (see examples in Table 1).

For those of you who still feel that we are placing too much emphasis on species at the expense of whole communities, may I remind you that it is often possible to repair or partly restore a particular community, but if we lose a species we don't get a second chance.

5. HOW CAN WE BETTER CONTROL INVASIVE SPECIES?

At the outset we must distinguish between *intentional* and *accidental* introductions. Intentional introductions may be *legal* or *illegal.* The new Biosecurity Act 1993 goes some way towards providing the country with control of legal introductions. Illegal and accidental introductions of invasive species remain as the larger part of the invasives problem. Animals like the gypsy moth and the white-spotted tussock moth will always be difficult to keep out. But what about the legal importation of leopard cat genes in the hybrid Bengal cat? Have the implications of this introduction been fully assessed? What if characteristics of the leopard cat, such as larger size, are spread through the wild population in New Zealand resulting in altered predatory impact on indigenous wildlife? And what about the very recent introduction of locomotives from Australia that were carrying, we are told, three tonnes of soil containing wasps, red-backed spiders and seeds of several noxious weeds. Why were they not detected until after they had arrived in the country? We have to ask whether we are always serious about border control.

I think that if we are to strengthen our battle against invasive species we must do much more anticipatory planning and this will require greater co-operation with other countries. We could checklist the new species of problem invasives, plants and animals, that we are most likely to receive from other countries. Using that list we could design methods for their earliest possible detection and then establish detailed contingency plans for rapid responses to each of these potential invasives (Atkinson 1996b). Some groups of potential invasive species could be covered by a single contingency plan.

What about invasive species that are already well established in the country? I believe that 'invasion biologists' around the world have spent too much time trying to identify the characteristics of a species that make it a successful invader—without many generalisations of practical value emerging. For that reason we may be better off trying to identify the factors that restrict the further spread of a successful invader (Atkinson & Cameron 1993). Investing time in that kind of research may give us a few keys to more effective control of some problem plants and animals. Why, for example, are rats now absent from large parts of Fiordland even though they were reported as abundant there last century?

6. HOW CAN WE ACHIEVE MORE RIGOROUS RESTORATION PROGRAMMES?

We have three major options for managing our indigenous biodiversity: protecting what we have, restoring part of what we have lost, and harvesting what may be appropriate to harvest on a sustainable basis. The restoration option, apart from its benefits to biodiversity, can be a remarkably effective way of involving a wider range of people than other kinds of conservation effort. Restoration programmes generate commitment from people of all ages, often individuals who apparently are not so interested in volunteering their time for purely protective action. But the goals of many restoration programmes are poorly defined, sometimes because local people have not been involved in formulating those goals, and therefore have no sense of 'ownership' for the programme. Whatever the exact reasons for this failure, the result is that we do not make the best use of available resources.

Restoration scientists are at least partly to blame for this. As I see it, there is insufficient agreement among us, at least in New Zealand, as to what constitutes an attainable goal for a restoration programme. Some argue that trying to restore communities of the past, for example, is impractical because of species losses from extinction. May I ask what terrestrial community in New Zealand has not lost species that were present in prehuman times? Does that mean it is impractical to protect what is left?

Others consider that any restored community will contain so many species of introduced plants and animals that the resulting combination of species will be of little value. What protected community in New Zealand is without many species of introduced plants and animals? Does that mean that all protected communities are of little value?

Then there is the problem of trying to rebuild a past community that, invariably, was changing in time as a result of both internal (autogenic) processes as well as those associated with natural disturbance—a problem aptly described by Simberloff (1990) as one of trying to hit a moving target that is fuzzy and whose trajectory cannot be predicted accurately. If we do not fully acknowledge the changing character of all biotic communities, we may focus too much on details of community composition that may be less important than understanding how the community to be restored once functioned.

One possible way through this difficulty is to ask ourselves: 'What were the *major selective forces* operating during the historic or prehistoric time period of the community to be restored?' (Atkinson 1997). Identifying these selective forces would allow us to build descriptive models of the communities we wish to restore from which realistic goals and objectives could be derived. Such models would emphasise factors that formerly influenced the community of interest, identify factors that would not have been operating during that time period, and possibly make some educated guesses about the rate at which the community could have been changing. In identifying past selective forces we need to focus on species-specific selection regimes, those influenced by predators, herbivores, competitors, pollinators and seed dispersers. There are some opportunities to restore these regimes whereas our options for restoring independent factors of the ecosystem such as past climates or particular geological/hydrological conditions are far more limited. This is why I prefer to talk about 'restoring communities' rather than 'restoring ecosystems'; the latter phrase seems unrealistically ambitious. Restoration biologists, including myself, will need to pay more attention to restoration models if we are to achieve greater rigour and thus more effective restoration programmes.

7. CAN WE IMPROVE ATTITUDES TOWARDS RESEARCH IN BIODIVERSITY?

There are two points I wish to make here. There are only a small number of scientists in the country with sufficient expertise and experience to make a real dent in some of our biodiversity problems. The dogma of market forces has compelled these people to compete against each other for whatever money is available. There is now less communication and much less co-operation than there used to be. This is a very inefficient way of using a scarce human resource. Only a change in government policy will alter this situation.

The second point concerns the Department of Conservation. There are a number of good things that have happened in the Department with respect to the application of research to biodiversity problems. In managing threatened species, for example, the level of science and technology now applied to the

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[1] **Adaptive management** (also known as 'research-by-management') refers to a situation where small numbers of a threatened species or limitations of habitat, preclude a replicated experiment in seeking the cause of the species' decline. The threatened population is, instead, subjected to differing management treatments (e.g. predator control versus no control), with systematic monitoring of outcomes. Ideally, following a suitable time interval, treatments are switched at the same site.

kakapo problem is second to none in New Zealand (and possibly in the world). Other examples of intensive research within the Department, applied to a specific conservation problem, are the re-establishment of rare or threatened species of skink on islands in the Mercury group (Towns 1994) and the effects of trapping stoats in increasing the breeding success of yellowheads (O'Donnell et al. 1996). Then there are the successes achieved by using an 'adaptive management' approach[1] to endangered birds such as kokako in the North Island and parea (Chatham Island pigeon) in the Chatham Islands.

However, these successes have been achieved against a background environment in which the Department's scientific expertise has been whittled away and remaining scientists have been repeatedly switched from job to job and continually pressured to engage in managerial tasks. The problem is more fundamental than lack of money. It is a problem of attitude which, although not universal, can be found at all levels in the Department. There are some who apparently think they do not need scientists: 'We can buy in expertise when we need it'. That might be good news for outside contractors, but the Department must realise that it will never obtain from contractors the kind of long-term commitment necessary to solve the really difficult problems. This is particularly the case with endangered animal species, where low productivity and long periods to reach sexual maturity cannot be encompassed by contracts of one or two years duration. Furthermore, without strong internal scientific expertise the Department cannot properly evaluate the contract work it commissions.

Although scientific research is not value-free, if done by properly trained and committed people, working individually or in teams, it is the most effective way yet devised by humans to gain new understanding of the physical world and thus new approaches to difficult technical problems. Properly trained researchers do not grow on trees: they require five to ten years of intensive training and then several years of practical experience before they can make significant contributions. It is inefficient to then divert their expertise towards essentially non-scientific problems, important as these may be.

Answers to biodiversity problems will not always be forthcoming from scientific research, but to think that such problems can be solved by 'better management' or 'committees of experts' (including scientists) is a time-wasting dream. Problems of significance are seldom easy to solve, and those researching them need encouragement. What was said to this conference earlier this morning gives me hope that DOC scientists will have more support and encouragement in the future than has been the case in the past[2].

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[2] **Footnote added in March 1998:** The Department of Conservation's strategic business plan for 1998–2002: Restoring the Dawn Chorus, was published in January 1998. Some of its conservation goals are ambitious; they will not be achieved without substantial scientific and technical input, a fact not mentioned in the plan. It would have been helpful to both DOC scientists and the wider scientific community if this fact had been acknowledged.

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