CHAPTER THREE

# Conservation biology in Australia: where should it be heading, will it be applied?

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The overall aim of conservation biology is to prevent loss of biodiversity. To be successful, conservation biology must produce the information needed by conservation policy makers, bureaucrats and managers, and be applied. The challenge for conservation biologists is to meet needs in systematics, ecological survey and monitoring, the management of individual threatened taxa (including *ex situ* conservation where appropriate), exotic species control, conservation genetics, ecosystem management, and conservation outside reserves. Suggested priorities for Australia are to finalize the alpha taxonomy of vascular plants, vertebrates and selected invertebrates and non-vascular plants, co-ordinate and develop biogeographic surveys and surveys of threatened taxa, implement long-term monitoring, complete the reservation of the protected area system, prevent extinctions among vascular plants and vertebrates, control foxes, cats, rabbits and *Phytophthora*, develop appropriate fire regimes for major biomes, develop and implement education about conservation biology and manage reserves, including islands. Conservation biologists must think long-term, integrate research with management and tackle the basic causes of biodiversity loss. An examination of the application of conservation biology in Australia suggests that, while there has been much recent progress, conservation biology is having limited impact. Unless conservation biologists market themselves and their science successfully, there is every chance that biodiversity will continue to be lost, to the detriment of human existence.

Key words: conservation biology, research, conservation managers, threatened species, threatening processes, biodiversity, protected areas, priorities, fire, islands.

## INTRODUCTION

THE fundamental aim of conservation biology must be to prevent the loss of biodiversity. Strategies to achieve this aim are (after Western 1989):

1. To identify biological conservation problems.
2. To develop scientific conservation principles.
3. To establish corrective procedures.
4. To bridge science and management by making scientists responsive to the conservation problems and managers responsive to biological issues.

To me, conservation biology includes the politics, as well as the science and management of biodiversity conservation.

What follows is a personal view based on my experience in the science and management (and politics at the level of a senior public servant) of nature conservation in Australia, particularly Western Australia.

The last of the above four strategies, the one that I will be concentrating on, asserts that conservation biology is useful. In my view conservation biology will not succeed unless it is applied and conservation biologists can not be deemed to be successful unless they ensure the application of their science. This may appear a highly utilitarian view of science, but conservation biology could be considered a special case: if the world is to remain a healthy environment for humans, conservation biology must expand and be applied; the same consideration does not apply to many other sciences.

I will first discuss what I see as the challenges for conservation biologists in Australia and then discuss how the challenges might be realized. Since I believe that conservation biology must be an applied science, I will try to concentrate on the needs of conservation policy makers (politicians and bureaucrats) and managers in the field. Since many people are pessimistic about nature conservation, concentrating on failures of conservation policy and practice rather than on successes, I will provide some case studies from the Western Australian Department of Conservation and Land Management (CALM) to demonstrate that successes are both possible and happening, as well as to highlight problems.

## THE CHALLENGE FOR CONSERVATION BIOLOGISTS

### *Systematics*

The description and classification of biological diversity must be advanced considerably. Managers can not conserve biological diversity unless they know what there is to conserve and politicians and the public will not support the

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Pages 27–37 *in* CONSERVATION BIOLOGY IN AUSTRALIA AND OCEANIA, ed by C. Moritz and J. Kikkawa. Surrey Beatty & Sons, Chipping Norton. 1993.

conservation of un-named entities. As well, reliably applied names allow biologists to communicate about plants and animals; this is particularly important when computer databases (including geographic information systems) are used to manage biological and conservation information.

Many managers and bureaucrats do not appreciate the need for further taxonomic studies; indeed some express the view that changes in generic names and descriptions of myriads of new species are designed simply to make their lives difficult and that taxonomists should be mere "identifiers", spending most of their time attaching names to specimens and producing species lists for parks and reserves. Perhaps, because of this view, the staffing and resourcing of Australian museums and herbaria have not kept pace with the growth in demand from conservation agencies, conservation biologists and the public. Within some museums and herbaria, descriptive taxonomists are tending to be replaced by people more interested in the application of modern technology to systematics and less interested in naming new species. Some museums, e.g., the Western Australian Museum, have, over the past few decades, allocated an increased proportion of their resources to collecting and displaying objects of cultural or historical importance, and less resources to extending, curating and naming their natural science collections and, at the policy level, seem to have gradually reduced their interest in nature conservation. On the other hand, the Western Australian Herbarium was recently transferred from the Department of Agriculture to CALM and its priorities are now being driven primarily by conservation needs.

Taxonomy has declined both as a subject to be taught and as one to be researched (Thomas 1991), especially within universities. In these days of consumer-oriented university courses, taxonomy is increasingly ignored. Conservation biologists should lobby for taxonomy to be retained as a subject taught and practised in universities and other research institutions.

*Case study 1 — How many species of vascular plants are there in the South West Botanical Province?*

There has been no published estimate of the number of vascular plant species in the South West Botanical Province since that of Beard (1969), who recorded a figure of 3 600 Angiosperms and 11 Gymnosperms. Green (1975) recorded 7 964 species for the whole of Western Australia, but provided no breakdown into Phytogeographic Regions. Hopper *et al.* (1990) state "it seems likely that the true figure (for whole of the State) will exceed 10 000 when botanists complete the task of collecting, researching and describing this remarkable biological resource." Botanists with wide experience in the south-west have made verbal estimates ranging from 9 000 to 15 000 species for the Province. How can conservation of this flora (and the fauna that depends on it) take place at either the species or genetic level of biodiversity without an understanding of taxonomic boundaries?

The effects of taxonomic advances on conservation practice can be demonstrated by the genus *Verticordia* (Myrtaceae). In Western Australia there is powerful legislation that protects taxa of plants declared to be threatened with extinction, whether they exist on public or private land. Green (1985) listed 53 species of *Verticordia* and at that time CALM recognized 14 declared threatened and priority taxa (apparently rare taxa in need of further survey) within the genus (see Hopper *et al.* 1990). After George's (1990) generic revision, 90 species were recognized from Western Australia plus 42 infra-specific taxa. Now CALM recognizes 69 priority and declared taxa of *Verticordia* in the State, most from the heavily cleared agricultural areas of the wheatbelt. This is a clear case where taxonomic research provided extra protection for threatened taxa and promoted research into their conservation.

***Establishing and monitoring conservation status***

Many areas of Australia have not had even a cursory biogeographic survey and the conservation status of many taxa, even those in relatively well known groups such as vertebrate animals and vascular plants, is completely unknown. Australia is probably the only "western" country where even the status of many mammal species is not known. Many collections and their associated biogeographic data bases are poorly housed and curated and the data in them are not easily accessible to users. On the other hand we have also seen rapid advances in the theory and practice of surveys and the use of computers to store and analyse data. Surveys of high standard and of immediate use to policy makers and planners are being conducted, analysed and, importantly, published (e.g., the Nullarbor Plain survey: McKenzie and Robinson 1987; McKenzie *et al.* 1989, 1991a).

As well as broad biogeographic surveys of whole districts or areas of particular interest, surveys are required to establish the status of taxa presumed to be threatened with extinction. Without such surveys, policy makers can not promote nature conservation within a system of representative protected areas, nor can managers concentrate their limited resources on the management of the most important places, communities or species.

Long-term monitoring of ecosystem change and trends in the status of individual taxa is infrequent and localized in Australia, even though some biogeographic surveys are now establishing series of permanently marked sites for future monitoring, for example, the recent Kimberley rainforest survey (McKenzie *et al.* 1991b). Monitoring is not seen as "good" science by many scientists and is not promoted in universities; little is being conducted within conservation agencies. Within CALM, for example, although a policy on monitoring was published several years ago and although techniques for monitoring have been developed, the policy has not been implemented because of lack of resources (i.e., other matters were seen as more important). Without monitoring how can we evaluate the results of conservation management and how can we distinguish between natural and human-caused change?

*Case study 2 — How many taxa of vascular plants are recently extinct?*

Clearly, data are needed on the conservation status of a particular plant taxon before it can be declared to be threatened under Western Australia's flora conservation legislation. The declaration of plants that turn out to be common could result in politicians and the public losing respect for the whole process and provide ammunition to those opposed to such measures to lobby for their repeal. Plants are now added to the schedule of declared threatened flora according to a set of criteria that include rigorous requirements for survey to establish the conservation status of the more than 2 000 poorly known and possibly threatened Western Australian species that have been listed in the past by various authors.

As part of this process a "presumed extinct" list of named taxa has been prepared. This list has been reduced from over 100 taxa in 1985, to 94 in 1989 and 53 in 1991. While some reduction has resulted from changing definitions of "presumed extinct" and from taxonomic research, most have been found by diligent searching, especially following increased interest in threatened flora by CALM staff and amateur botanists resulting from the publication of an authoritative book on the subject (Hopper *et al.* 1990). For example, the only eucalypt listed as presumed extinct, *Eucalyptus rameliana*, has recently been relocated by wildflower picker and amateur botanist Nick Foote (Hopper 1992). Prior to this the taxon was known from a single collection made by the explorer Ernest Giles in 1860. Grants for detailed searches for threatened flora from the Australian National Parks and Wildlife Service's (ANPWS) Endangered Species Program and from the World Wide Fund for Nature Australia (WWF Australia) have also resulted in presumed extinct taxa being located.

### Conservation management of individual taxa

Critically endangered taxa must be identified, ranked and managed. It is vital that we identify the factors that are causing extinctions. Recovery must be the aim.

Within Australia we know that there are relatively large numbers of threatened vascular plants and mammals, and significant numbers of other vertebrates that are threatened. Few data are available on invertebrates and non-vascular plants. The Commonwealth Government has recently decided to allocate resources to the conservation of threatened species, an area previously restricted to the States and Territories. This has already led to a significant improvement in the number of species being addressed; it has also led to funds being allocated for the first time to research into the biological control of major pests which are of nature conservation, rather than agricultural, importance, e.g., the European Red Fox and *Mimosa pigra*.

Non-government organizations (NGOs) are becoming increasingly active in the conservation of threatened species, with WWF Australia taking the lead. Co-ordination of government and non-government organizations is proceeding well through such mechanisms as the The World Conservation Union's (IUCN) Species Survival Commission Specialist Groups, the Commonwealth's Endangered Species Advisory Committee and the production of Action Plans and Recovery Plans. At present progress is based on co-operation and it is to be hoped that threatened species will not become another "states rights" political issue, since many NGOs (e.g., the Australian Conservation Foundation and WWF Australia) are lobbying the Commonwealth Government to pass legislation that overrides State conservation and environment legislation. In my view this would achieve little except divisiveness and rancour, and would also divert State conservation biologists from real conservation work towards politics and argument.

Recovery of threatened taxa is possible with good research and good management. Some Western Australian taxa that have made remarkable recoveries in recent times include the Numbat *Myrmecobius fasciatus*, Woylie *Bettongia penicillata*, and Noisy Scrub-bird *Atrichornis clamosus*.

*Case study 3 — The Noisy Scrub-bird*

When the Noisy Scrub-bird was rediscovered in 1961 there were about 40 to 45 territorial males (only singing males can be counted) left in one population on Mount Gardner in what is now Two Peoples Bay Nature Reserve. Since then its habitat has been legally protected, its biology and ecology have been described (e.g. Smith 1985 a,b), fire management of its habitat has been implemented, translocation methods have been developed and instituted and a management plan written and partially implemented (Burbidge *et al.* 1986). The number of territorial males rose from 45 in 1970 to 69 in 1975, 111 in 1980, 157 in 1985 and 293 in 1991 (Burbidge *et al.* 1986; A. Danks, pers. comm.). During the same period, the number of presumed viable populations rose from one to three. This is a good example of dedicated and co-ordinated action by scientists (including Don Merton of the New Zealand Department of Conservation), managers and policy makers leading to a successful result.

Although *in situ* conservation must always be the long-term aim, there is a need to develop and implement realistic methods of maintaining biodiversity outside natural areas where appropriate, including *ex situ* techniques such as captive breeding, propagation and cryo-conservation, so that species can be re-introduced to the wild when problems such as dieback disease caused by *Phytophthora* species (see below) are solved.

*Case study 4 — The Western Swamp Tortoise*

The Western Swamp Tortoise *Pseudemydura umbrina* is the world's rarest chelonian and one of its most endangered animals, with only around 30 individuals remaining in the wild. A combination of small geographic range, habitat destruction, drought and fox predation has led to its near demise (Burbidge *et al.* 1990). The application of modern technology (ultra-sound scanning of the female reproductive tract; Kuchling 1989; Kuchling and Bradshaw, 1993), better animal husbandry (Kuchling and DeJose 1989), and the co-operation of researchers and managers from The University of Western Australia's Zoology Department (especially Dr Gerald Kuchling), Perth Zoo and the Department of Conservation and Land Management (together working as members of a Recovery Team), plus generous funding from the WWF Australia, federal and State conservation agencies and private sponsors have resulted in a small captive population that had stopped breeding turning into one that is producing hatchlings at a rate that will allow re-introduction to the wild. The number of captives has increased from 12 in 1980 to 61 in May 1992 (Burbidge 1991; Burbidge and Kuchling, in press). Because of the long time to sexual maturity (10 to 15 years) it will be some years before a significant number of captives become available for restocking.

Fortunately, similar projects, involving both animals and plants, are becoming increasingly common. Experience with these shows that we cannot afford the luxury of having museums, zoos, herbaria, botanic gardens and germplasm facilities working to their own agendas and deciding priorities separately from conservation agencies. Mechanisms need to be developed so that these organizations can contribute to the development of conservation priorities and participate in their implementation.

### *Exotic species*

We must solve the problem posed by exotics. In Australia exotics have had an enormous effect. Australia is an island in ecological terms, not a continent: modern rates of extinction are unparalleled elsewhere except on islands. In my view the top priority exotics from a nature conservation perspective are, for vascular plants, *Phytophthora* spp. and for vertebrate animals, foxes, cats and rabbits. Bushland weeds are a major problem for many ecosystems; because of the multiplicity of species and their largely local effects, priorities for control must be set at a regional rather than national level.

*Case study 5 — The Red Fox and native prey species*

While many mammalogists warned that exotic predators could be a cause of decline and extinction in Australia (e.g., Calaby 1971; Christensen 1980) such warnings were largely ignored by policy makers and managers because of a lack of proof, statements in ecological texts that predators could not eliminate prey species on a continental scale (e.g., Frankel and Soulé 1981) and the lack of suitable fox control techniques. It took the pioneering work of Kinnear (1988, 1991) to prove that the fox could be controlled and that control resulted in the recovery of remnant rock-wallaby populations. In Western Australia this quickly led to similar results with other species, e.g., the numbat (Friend 1990). CALM applied Kinnear's results even before his research papers were published and fox control, using meat and egg baits with "1080" (an environmentally-friendly toxin in Western Australia, King and Kinnear 1991), was carried out around remnant populations of a variety of threatened species. As well as black-footed rock-wallabies and numbats, dramatic recovery has now been demonstrated in Common Brushtail Possums *Trichosurus vulpecula*, Woylies *Bettongia penicillata*, Rothschild's Rock-wallaby *Petrogale rothschildi*, Tammar Wallabies *Macropus eugenii* and Western Brush Wallabies *Macropus irma* (J. E. Kinnear, pers. comm.). Experiments are underway involving several other threatened taxa as small as the Western Mouse *Pseudomys occidentalis*, which has a mean adult body weight of *ca.* 35 g and is at the lower end of the critical weight range of Burbidge and McKenzie (1989). Kinnear's seminal work has led to a reappraisal of the role of exotic predators in Australia and to research being commenced into the biological control of foxes.

*Case study 6 — Phytophthora*

At least eight taxa of *Phytophthora* have been introduced to Australia (Shearer and Tippett 1988). In the south-west of Western Australia they have been spread widely, mainly through human activity, and are now having a dramatic effect on the native flora. Indigenous species most affected belong to four families: Proteaceae, Epacridaceae, Papilionaceae and Myrtaceae. These four families account for a very high proportion (over 50%) of the plants in many ecosystems of the south-west of Western Australia. Species from several other families are also affected. Data on the response of indigenous species to infection are inadequate to make accurate estimates of the total number of susceptible species. Broad estimates are that perhaps 1 500 to 2 000 species of vascular plants in the south-west may be susceptible to infection, although not all occur in places where the disease is likely to be expressed.

Many threatened plant species could become endangered or extinct through infection by *Phytophthora* in the coming decades. For example, all known populations of *Banksia brownii*, the Feather-leafed Banksia, are infected and all infected plants die. During the relatively short time that it has been present, *Phytophthora* has changed the structure and diversity of many plant communities in the state, with unknown consequences for many taxa of animals. There is no known method of eradicating *Phytophthora* in native vegetation. Disinfectants and fumigants used in horticulture are toxic to plants and if used in bushland could do more damage to native vegetation than the fungus. Recently a number of systemic fungicides have become available and are being increasingly used in horticulture. The most promising one for use in bushland is neutralized Phosphorous Acid ($H_3PO_3$). Shearer (pers. comm.) has shown that applications of phosphorous acid can arrest expression of the disease in several species of *Banksia*: much more work needs to be done to expand this research.

### Conservation genetics

The conservation of genetic diversity is a central tenet of the World Conservation Strategy, but conservation genetics is a new enough discipline that many managers have either not heard of it or do not understand it (Hopper and Coates 1990). Thus conservation geneticists firstly need to publicize the benefits that their science can bring to conservation; they also need to work closely with managers to ensure that they have the opportunity to learn of its application.

Of critical importance to policy makers and managers are questions concerning populations that have undergone a rapid reduction in size, for example because of deforestation. Does this result in a significant reduction in genetic diversity and heterozygosity and, if so, how critical is this to the short to medium term survival of that population? If a new population is to be established by translocation, how many individuals should comprise the founder population? Population viability is understood as a concept by managers but actually applying it is another matter.

*Case study 7 — Designing protected areas for eucalypts*

Selecting populations for inclusion in a protected area network may be aided if data on the level of genetic differentiation between populations, the presence of rare alleles in populations and the level of genetic diversity within each population is known. Hopper and Coates (1990) have discussed the different conservation strategies for Karri *Eucalyptus diversicolor*, which has little interpopulation differentiation (Coates and Sokolowski 1989), and Caesia *E. caesia*, which has large genetic distance values between populations (Moran and Hopper 1983). In the former a few large reserves plus protection of small outlier populations is sufficient to protect detectable genetic diversity, while in the latter many populations covering its geographic range need to be protected. When developing management prescriptions for the endangered Rose Mallee *Eucalyptus rhodantha*, Sampson *et al.* (1990) studied the distribution of genetic diversity within and between remnant stands and developed information on its breeding system before recommending which stands should be purchased for inclusion in the protected area network.

### Ecosystem management

Increasingly, conservation biologists think that biodiversity cannot be retained, nor ecosystem processes maintained, without intervention. Our understanding of ecosystems is in its infancy and, accordingly, our ability to manage ecosystems to achieve clear goals is poor. Clearly, more community and ecosystem research is needed that aims to provide solutions to major management issues, e.g., the control of and use of fire in the management of lands with nature conservation values.

The goal of ecosystem management in Australia must be to minimize the loss of biodiversity and the strategies to achieve this goal are:

1. Determine which areas of Australia need to be included in the protected area network and complete the reservation of representative areas of all biomes and major ecosystems (both terrestrial and marine) and other areas of particular conservation or landscape values in protected areas. The existing protected area network is far from representative. In

Australia we have developed the existing protected area network in competition with agriculture, and legislation and practice clearly reflect the view that the two land uses are largely incompatible. To extend the reserve system in much of Australia we must now develop an approach to land protection that dovetails as far as possible with the aspirations of Aborigines and the needs of the mining industry; at present these two land uses are preventing the declaration of many biologically important areas.

2. Manage protected areas in a "conservative and conservationist" manner. Conservation biologists should seek to intervene where it is clear that biodiversity is being lost or ecosystems are degrading and seek to oppose or defer interventions in ecosystems where outcomes are uncertain (Saunders and Burbidge 1988).

3. Promote the adoption of a "land ethic" by research and management agencies and the community at large. This concept has been around for many decades and was well stated by Aldo Leopold (1949): "A land ethic simply enlarges the boundaries of the community to include soils, waters, plants and animals, or collectively, the land". . . . "In short, a land ethic changes the role of *Homo sapiens* from conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow members, and also respect for the community as such."

4. Lobby for adequate resources to be allocated to agencies given the responsibility of managing land, ecosystems and species.

*Case study 8 — Patch burning in spinifex*

There has been a long association between fire and the Australian biota and the deserts are no exception. There is now much evidence that fire regimes in the spinifex hummock grass deserts have changed dramatically since the Aborigines abandoned their nomadic life-style for settlements (e.g., Latz and Griffin 1978; Kimber 1983) and that this may have led to profound changes in the composition of the biota, particularly mammals (Bolton and Latz 1978; Burbidge *et al.* 1988). A fire behaviour model developed by Griffin and Allan (1984), and applied in Uluru National Park, has now been refined for the different spinifex fuels of the Gibson Desert. As a response to the vast areas of conservation reserves in the desert and the lack of ground-based fire operational resources Burrows and van Didden (1991) have shown that aircraft can be used to burn numerous small patches over large areas at a low cost — 140 000 ha were burnt at the cost of A$0.32 $ha^{-1}$. Land managers were involved in these experiments from the start and were immediately keen to apply the new technique.

***Conservation outside reserves***

The reserves system alone can not protect the full range of biodiversity and policy makers and many community groups are grappling with the need for nature conservation outside protected areas, while maintaining economic activity. Mechanisms being used vary, but include the operations of Land Conservation District Committees and the Biosphere Reserve concept (e.g., Cribb 1987). Basic to the success of these ventures is the involvement of local people and the demonstration that good conservation practice benefits local productivity. Tree planting that both rehabilitates degraded land and produces a cash crop has considerable potential for both farmers and conservation (Shea and Bartle 1988). Many conservation biologists are working on off-reserve conservation and with local groups now; more contact between conservation biologists and land owners and users is needed.

## DEVELOPING PRIORITIES

Conservation biologists can not expect to achieve everything that I have proposed above in the near future. Thus, it is important to identify which issues in nature conservation are the most important and pressing and direct resources to them. Conservation biologists must work with policy makers and managers to develop widely accepted priorities and work to get funding directed to them. With the aim of stimulating debate I propose that the following areas receive priority in Australia (not in order of priority).

1. Improving alpha taxonomy. I believe that the first task is to classify vascular plants and vertebrates, and selected groups of invertebrates and non-vascular plants, so that their conservation can be addressed with reasonable confidence of taxonomic boundaries. Invertebrate and non-vascular groups selected should be those that
   i. are beautiful (because the public will empathize with them), or
   ii. show local endemism and low dispersability so that fine-grained patterns in the biota can be addressed in protected area system design (e.g., Solem and McKenzie 1991; McKenzie and Belbin 1991), or
   iii. are likely to be most affected by current environmental change.

2. Co-ordinating and developing biogeographic surveys and surveys of threatened taxa.

3. Establishing a representative protected area system.

4. Protecting and managing islands which contain ecosystems largely unaltered by the major disturbances on the mainland and species now extinct or threatened on the mainland (Burbidge 1989; Towns *et al.* 1990).

*Table 1.* Australian mammals that occur only on islands.

| Species | Island(s) |
|---|---|
| *Dasyurus viverrinus*, Eastern Quoll | Tasmania |
| *Sarcophilus harrisii*† Tasmanian Devil | Tasmania |
| *Pseudantechinus mimulus* Carpentarian Antechinus | Centre, North and South-west Sir Edward Pellew Group |
| *Perameles bougainville* Western Barred Bandicoot | Bernier, Dorre |
| *Bettongia lesueur* Burrowing Bettong | Barrow, Bernier, Dorre |
| *Bettongia gaimardii* Tasmanian Bettong | Tasmania, Bruny |
| *Lagostrophus fasciatus* Banded Hare-wallaby | Bernier and Dorre |
| *Thylogale billardieri* Tasmanian Pademelon | Tasmania and 16 other Tasmanian islands |
| *Leporillus conditor* Greater Stick-nest | Franklin, Reevesby*, Salutation* |
| *Pseudomys fieldi* Shark Bay Mouse | Bernier |
| *Pseudomys higginsi*† Long-tailed Mouse | Tasmania |

*introduced. †endemic to Tasmania in historic times.

For example, 13 Australian islands harbour populations of 13 endangered mammal taxa on the 1991 Australian and New Zealand Environment and Conservation Council (ANZECC) List of Australian Endangered Vertebrates (three populations are introduced) (ANPWS 1991), while 19 islands harbour populations of five vulnerable mammal taxa (two populations are introduced). Eleven species of Australian mammals occur only on islands and all except two of these occurred on the mainland in historic times (Table 1).

5. Preventing extinctions among vascular plants and vertebrates and developing cost-effective techniques that can be widely applied to the recovery of endangered species.
6. Working on control or eradication of the major threatening exotics: foxes, feral cats, rabbits, *Phytophthora* spp. and those bushland weeds that are threatening native species and whole ecosystems (e.g., Ward's Weed *Carrichtera annua* in the Nullarbor Plain, McKenzie *et al.* 1991).
7. Developing appropriate fire regimes for major biomes.
8. Developing and implementing appropriate education about conservation biology for all levels of society.
9. Marketing conservation biology and lobbying for resources.

In tackling these priorities conservation biologists must think long term. Most environmental research and management is short term. Long-term issues can probably only be addressed by government agencies or by large NGOs with continuity of existence and funding. Universities, because of the nature of their research funding have not, by and large, been places where long-term research has been done. This is regrettable, since most university researchers have tenure of employment and should, in my view, allocate a proportion of their time to addressing long-term issues. These problems should be addressed if universities are to contribute to the study of some of the major issues of conservation biology. I suggest that conservation biologists must commit a proportion of their time to long-term research and monitoring.

Without a reduction in human population growth and a change from non-sustaining economics, conservation and humanity are doomed — it is only a matter of time. World human population is increasing rapidly (Table 2). Conservation biologists must tithe a proportion of their time to explaining the basic tenets of conservation biology to lay audiences, especially to economists and accountants and to other scientists, engineers, etc.

While this chapter is concerned with conservation biology in Australia, conservation is obviously needed in developing countries as well as in developed ones. Thus, conservation biologists need to assist people from other countries and work to try to get conservation biology principles accepted and applied there.

## INTEGRATING RESEARCH AND MANAGEMENT

An often stated view of scientists and managers is that management goes on in isolation taking no account of research results and research is largely irrelevant, taking no account of management needs (Hobbs 1988). In fact conservation land managers use ecological theories in almost every decision they make. For example, most decisions about the management of protected areas are based on ecological principles.

Saunders and Burbidge (1988) pointed out that integration of research and management is fostered by:

- ensuring that research is relevant,
- using multi-disciplinary teams that include managers,
- improving research extension,
- effectively communicating research results,
- involving researchers in management and managers in research,
- holding subject-specific workshops to swap information, and
- ensuring managers keep up with scientific advances.

*Table 2.* Human population and population change in selected countries and the world (from World Conservation Monitoring Centre 1990).

| | Population (x10$^6$) | | | Average annual change (per cent) | | |
|---|---|---|---|---|---|---|
| | 1960 | 1990 | 2025 | 1965–70 | 1975–80 | 1985–90 |
| Australia | 10.3 | 16.7 | 22.7 | 1.95 | 1.51 | 1.22 |
| China | 657.5 | 1 135.5 | 1 492.6 | 2.61 | 1.43 | 1.39 |
| Fiji | 0.4 | 0.7 | 1.0 | 2.29 | 1.77 | 1.60 |
| India | 442.3 | 858.4 | 1 445.6 | 2.28 | 2.08 | 2.08 |
| New Zealand | 2.4 | 3.4 | 4.1 | 1.41 | 0.17 | 0.79 |
| Papua New Guinea | 1.9 | 4.0 | 8.6 | 2.00 | 2.70 | 2.66 |
| Solomon Islands | 0.1 | 0.3 | 0.8 | 2.79 | 3.01 | 3.96 |
| The World | 3 019.4 | 5 292.5 | 8 468.5 | 2.06 | 1.74 | 1.73 |

It is vital that researchers in conservation biology accept the responsibility of ensuring that their research is used by policy makers and managers. Whether scientists like it or not, conservation managers do not have the time, the inclination or the facilities to keep up with the latest research findings. Five essential steps to implementing research (after Underwood 1988) are:

1. The research study must be written up, refereed, published, and presented to colleagues at conferences, etc. This is to confirm the validity of the work and to find out whether the findings and conclusions are accepted by peers.
2. The research findings must be written up in non-technical language and presented to managers in the form of new policies or prescriptions. Often this can be achieved by the scientist joining a team that prepares a management or recovery plan and via seminars and "field days". A monitoring programme must be written into the plan.
3. In most cases research projects must be scaled up to an operational or demonstration trial. Again, these are usually best organized as collaborative projects between the researcher and operations staff.
4. The research scientist must participate in the initial training of staff who are going to carry out the actual work. This not only avoids serious misinterpretation but also may highlight any shortcomings of the research study.
5. The research scientist must participate in subsequent reviews of procedures and prescriptions.

## WHAT IMPACT ARE CONSERVATION BIOLOGISTS HAVING?

Are conservation biologists having an impact now? To illustrate the current level of applied conservation biology I will examine a hypothetical near-metropolitan area national park and a typical threatened taxon or community. The desirable and typical level of knowledge about and management of a protected area in Australia, based on my experience, is listed in Table 3, while the desirable and typical level of knowledge and management of a threatened taxon or community is given in Table 4.

These tabulations suggest that we have a long way to go. No one would deny that there have been major achievements in recent years, but there is still much to be done.

Why is this so? Partly it is because ecology and conservation biology are young sciences. Partly it is because governments and universities have put few resources into nature conservation. However, this is not the whole story — money has been spent and staff have been employed, but the ratio of conservation biologists to other staff in conservation agencies, universities and large companies is far from ideal.

In conservation agencies, I think this is because many of those who hire staff either think that conservation biologists have little to offer them, or else they believe that hiring other staff (administrators, managers, rangers, policy advisers, planners, etc.) and spending money on recreation is more in tune with public demand. Recently I visited a well-known near-city park and found that there were 15 rangers, but not a single conservation biologist, employed there.

It is true that at present few new jobs are being created because the economic woes of the country are being blamed in part on a "fat" public sector, but conservation biology is not so new as all that. What is needed is a better balance of staff in existing organizations. CALM employs 60 research scientists among a total research staff of 130 — around 10 per cent of its total number of employees. If research is to be translated into management it is imperative that conservation agencies retain and support their own research staff and that they are able to influence policy and practice at all levels. In CALM, the Director of Research is a member of the Department's Corporate Executive, where he can have direct input into all major policy decisions. Does your conservation agency employ enough scientists and are they able to influence policy at the highest level?

*Table 3.* Desirable and typical level of knowledge and management of a hypothetical near-Metropolitan large protected area in Australia.

| Topic | Desirable knowledge | Typical knowledge/situation |
|---|---|---|
| Biogeography | Good knowledge of distribution of ecosystems and taxa, including threatened taxa and communities. | Some species lists, but almost no data about distribution and abundance of ecosystems communities or taxa. Anecdotal data only on threatened taxa. |
| Monitoring | Site-based ecosystem monitoring and monitoring of threatened taxa populations. | No site based ecosystem or species monitoring. |
| Planning | Written plan of management that includes ecosystem and taxon management. | No written plan of management, or if plan exists, it does not include any meaningful ecosystem or taxon management. |
| History | Good record keeping of all actions and decisions (including decisions not to do something). | Poor record keeping, no records of "non-decisions". |
| Resources | Adequate number of well-trained, motivated staff with adequate finance. Ratio of conservation biologists to ranger and other staff better than 1:5. Ratio of resources committed to ecosystem, taxon and genetic resource management versus recreation and other management better than 1:1. | Budget of $500 000, ten rangers, no conservation biologists. Almost all management dollars being spent on visitor management and fire protection and almost none on ecosystem or taxon management. No management of genetic diversity. |
| Facilities | Quality, well-sited recreational facilities allowing a variety of "experiences". Demand for extra facilities managed to prevent degradation. | Increasing demand for recreation facilities leading to environmental degradation. |
| Interpretation | High quality interpretation of natural resources and nature conservation issues. | Some interpretation about local environment, little or none about conservation issues. |
| Cental support | Head and Regional Offices and Research Centres able to provide good support to managers. | Management agency spends most time fighting political battles and is ill-equipped to deal with conservation biology issues. Central research staff rarely visit area. |
| Public attitude | Public support for area and for management aims and techniques. | Little public support for management for conservation and little public understanding of real conservation issues. Public outcry about management practices that have visual impact, e.g., fire. |

## A FUTURE FOR CONSERVATION BIOLOGY?

As stated above, my view is that conservation biology will flourish only if it is applied. Application of conservation biology is happening and will continue, but will sufficient conservation biology be conducted and will sufficient be applied to prevent significant losses of biodiversity? It seems to me that unless we conservation biologists market the science of conservation biology and market ourselves as practitioners of the science we will have little impact. We must get out into the community to educate people about the benefits of conservation biology. We must lobby politicians, join political parties, get stories into the news media, raise money, and so on. The role of conservation biologists who work outside government agencies is particularly important, since they have greater freedom to criticize and cajole politicians.

In considering our approach to marketing we need to question the attitude of many people who call themselves "conservationists" at present. The conservation issues the public hears about are often those concerning the "rare" (critically endangered taxa), the "large" (e.g., whales, tall forest trees) or the "pretty" (e.g., koalas). This approach ignores most of the long-term major issues associated with the conservation of biodiversity and the biosphere. It

*Table 4.* Desirable and typical level of knowledge and management for an Australian threatened taxon or community.

| Topic | Desirable knowledge | Typical knowledge |
|---|---|---|
| Distribution and abundance | Good knowledge of changes in distribution and abundance. | Anecdotal data on distribution, few data on changes in distribution and abundance. |
| Knowledge | Good knowledge of population biology and ecology, especially limiting factors. | Poor knowledge of population biology and ecology, poor understanding of limiting factors. |
| Population genetics | Adequate data on genetic variation and breeding system. | No data on population genetics or breeding system. |
| Management goals | Well-defined management goals based on written recovery plan. | Management goals based on best guess; no written recovery plan. |
| Human and financial resources | Adequate resources to ensure persistence and recovery. | Insufficient research or management resources. |

means that the public tends to place no value on most ecosystems and species until they are threatened and it is too late to do much about them. Compare, for example, the public interest in the management of Australia's rangelands and forests; which covers a greater area and which is the more degraded?

We must also consider our approach to the implementation of research studies. It is not enough for scientists to conduct a study, identify some problems, suggest some solutions and leave it there. Clearly research into conservation biology is of only academic interest unless it is applied, but many conservation biologists appear uninterested in taking their research the next vital step.

In my view one measurement of the success of this book will be whether it leads to changes in attitudes of both scientists and managers. It seems that the organizers, who are scientists, have largely ignored conservation managers when inviting people to contribute chapters. Is this symptomatic of the problem?

If scientists within universities are interested in the study and application of conservation biology they must work more closely with scientists and managers in conservation agencies. They should also tap into new research funds, and not compete with conservation agencies for their scarce resources. They, and government conservation agencies, should lobby for conservation biology to be a long-term priority area for the Australian Research Council, which should seek input on funding priorities from a special panel of conservation managers and scientists.

Unless we demonstrate that conservation biology is "useful", conservation biologists will be neither employed by nor listened to by decision-makers, and they will not be given the resources necessary to save biodiversity, thereby helping to save the world. Unless conservation biologists are in demand, those of you who are training them will see your students fail to gain employment in their chosen career.

Unless today's conservation biologists convince decision-makers (including politicians, bureaucrats, economists and business people) that conservation biology has vital and practical applications, there is every chance that biodiversity will continue to be lost, to the detriment of human existence.

## ACKNOWLEDGEMENTS

I am most grateful for the help of many of my colleagues in the preparation of this chapter. My special thanks go to Neil Burrows, Per Christensen, David Coates, Steve Hopper, Neville Marchant, Norm McKenzie and Roger Underwood.

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◁ Pumistone Catchment, QDEH, 6 × 9.
The challenge facing conservation biologists; multiple land uses including intensive agriculture, pine plantations and natural forest remnants to the north of the Glasshouse Mountains, Queensland. Photo QDEH.

▽ Gambubal SF near Warwick, QDEH, 6 × 9.
Clean out logging at Gambubal State Forest. Photo QDEH.