

Confronting crises in conservation: a talk on the wild side

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ABSTRACT

Conservation of the Australian biota and rural and regional communities is at a critical crossroads and our generation is at the wheel. Three to five billion dollars in land degradation is accumulating every year, more species are going extinct here than on any other continent in the world and rural Australia is struggling with deepening cultural/economic crises about long-term viability. The perspective from deep time suggests that our current limited range of strategies for solving these crises, including reliance on the effectiveness of protected areas, will ultimately fail—sometimes catastrophically. Environmental and economic necessity urges us to consider all potential strategies that could turn this around, whether or not they fly in the face of conservative or minority group prejudices. Sustainable use of native wildlife, in urban as well as rural Australia, has the potential to increase the capacity for long-term effective conservation of the biota and rural and regional Australia, as it now does in other areas of the world such as southern Africa and as it once did in Australia when Indigenous people managed this continent. It may well offend animal rights advocates and environmental conservatives to suggest that valued wildlife could be the only alternative to no wildlife, but if that is the choice then there is no choice. The time has come to stand up to irrational views if they put at risk the long-term future of the natural and cultural things we value. Long-term conservation of the biota and rural and regional Australia requires that we trial new and potentially more effective ways of putting people and environments back together for the mutual benefit of both. This document overviews imperatives for change, potential if challenging initiatives that could assist traditional efforts and suggestions about how they might be translated into action.

Introduction

'Things have got to change' has become a universal mantra as we enter the third millennium increasingly worried about the ability of these things to survive into the fourth. Our ancestors spent the first two chewing off the umbilical cord of dependence on their gardens of Eden—stable, diverse ecosystems which they spurned, burned and turned into fragile monocultures that enabled rapid growth in human populations. By the beginning of the third millennium, unease had rapidly grown about the long-term survival capacity of growth spiral economies, fueled by awareness in the rate of decline in natural environments and in particular natural resources required for our own survival. Sector-specific reviews such as *Ecologically*

sustainable development working groups; final report—Agriculture (Anon., 1991) and *Agriculture and the environmental imperative* (Pratley & Robertson 1998), continent-wide reports such as *Australia: State of the Environment 1996 & 2001* and long-term overviews such as *From plesiosaurs to people: 100 million years of Australian environmental history* (Archer *et al.* 1998) challenge presumptions that what we are doing now will be sustainable in the long run. We continue to deplete Australia's natural capital faster than it can regenerate, a suicidal strategy for any economic manager.

This is not to say that the often Herculean efforts by many groups, government agencies, NGOs and individuals (see below), to maximise the effectiveness of traditional conservation

strategies, from the 1970s to the present, has in any way been a waste of time or inappropriate effort—quite the contrary. They have been essential in holding back the tidal wave of unsustainable, short-term financial gain strategies focused on the natural world. Examples include the commitments by individuals and organisations, risking their necks and/or their jobs in the process, to save threatened habitats, link isolated parts of ecosystems via corridors into larger, more viable entities, and frustrate efforts that would result in destruction of old-growth forests. The gains many dedicated conservation groups and individuals such as Bob Brown have made in ‘holding the line’ deserve Nobel Prizes for Environmental Protection. My focus here, however, is not on the good things that have been done up to this point; it is on what must happen from this point forward if those essential gains are not to have been made in vain. On their own, as critical as they have been in keeping ecosystems alive, they cannot ensure the future for those ecosystems or the communities on which those ecosystems now depend.

The heart of the problem is the rapidly-growing human population on planet Earth and its increasing per capita demand for resources (Ehrlich & Ehrlich 1996, Ehrlich *et al.* 1995).

The State of World Population 2001 report *Footprints and milestones: population and environmental change*, released by the United Nations Population Fund reported that more people are using more resources with more intensity and leaving a bigger ‘footprint’ on the Earth than ever before. Having doubled to 6.1 billion people since 1960, it predicts a further increase in world population to 9.3 billion by 2050 with corresponding negative impacts on environments. Despite the ravages of disease and regional acceptance of the need for birth control, global population grows in most countries without plan. So long as religious beliefs and ignorance obstruct birth control, the situation will get worse. (Fig. 1.)

In Australia’s case, we need to develop a scientifically-credible population policy based on *ecological* sustainability issues (Jones 2000, 2001) or accept that no lasting solutions to our environmental crises are going to work. Although current ‘guesstimates’ range from 1 to 50 million, we have a good indication of how many humans *cannot* be ecologically sustained, maintaining our standard of living. Considering the high and increasing land degradation costs Australia suffers with 19 million people, it can be argued that we are already significantly over-populated.

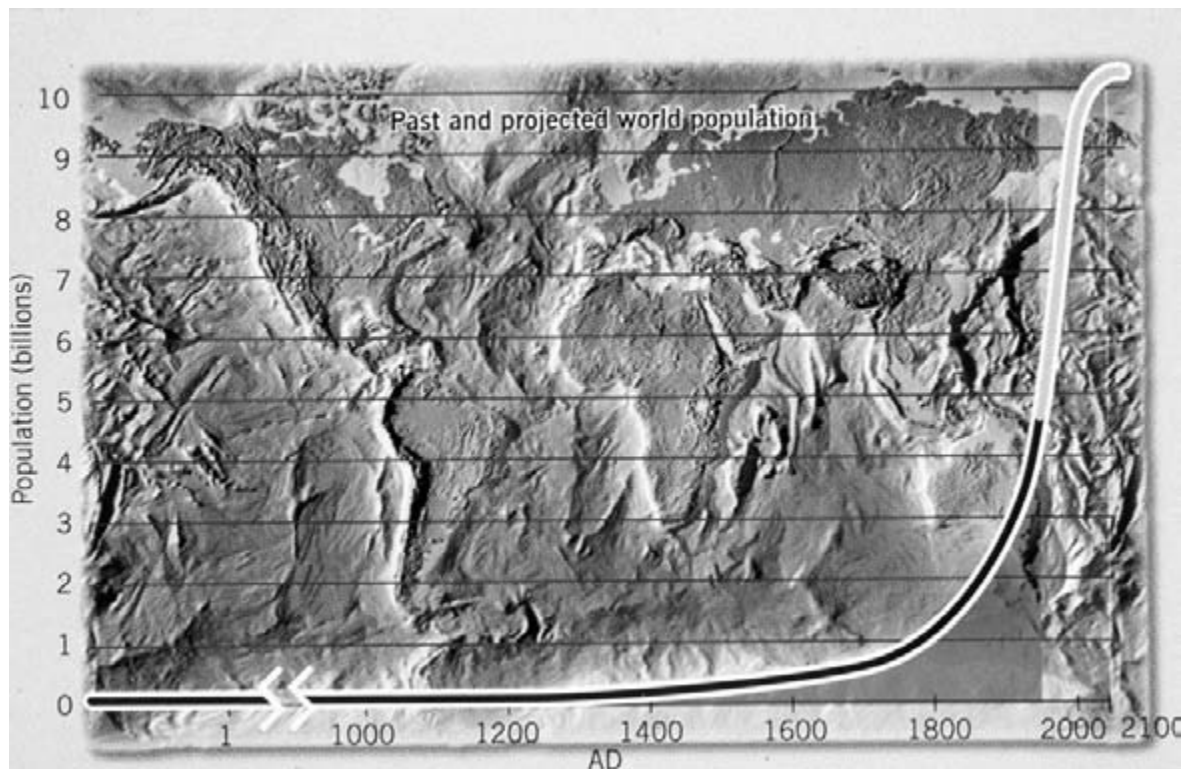


Fig. 1. The underpinning cause of most environmental abuse and failure to conserve is the growing population of Humans, both here and overseas. Australia, with 19 million people, may already be unsustainably overpopulated. (Courtesy Nature Focus and Nature Australia).

Although it is not just a question of population size but also of how that population is distributed and how it uses the land to produce a particular standard of living, it is with the former issue that this issues paper is primarily concerned. And it is not a constant number that Australia has to be able to support because its population size is rapidly increasing. Recent figures for Sydney, for example, demonstrate that it is growing faster now than it has in the last eight years and is expected to reach 4.5 million by 2013, eight years ahead of schedule (Humphries 2001).

The constantly increasing needs of our growing population have led to land clearance which is occurring at rates recently found to be far higher than previously thought—688 km²/year or the equivalent of 50 football fields every hour), soil erosion, rising water tables, salinisation, desertification, plagues of introduced species, simplification of ecosystems, eutrophication of water resources, death of once great river systems, globally-shocking rates of extinction and other losses—currently adding up to a \$3-5 billion land degradation cost that adds each year to an accumulating overall land damage deficit of at least \$60 billion. We are driving ourselves and Australia into this environmental black hole by destroying the natural capital of the land. Add to

this the as yet immeasurable impact of climate change on the whole of the continent and our children have, on current projections, not a lot in their future to smile about. (Fig. 2.)

Land damage has been exacerbated by financial and humanitarian incentives to feed 50 million people offshore in addition to the 19 million resident in Australia. Many would argue, accordingly, the wisdom of producing enough food to sustainably feed Australians and no more, thereby cutting down on food production and land damage by perhaps 71%. This proposition, however, which focuses on the welfare of the environment, does not address the triple bottom line critical in arguments of this kind. It ignores the rural/regional Australian *communities* and the *economic* consequences that such a cut-back would have. These communities depend on the income from exports to survive and produce the food needed by 19 million Australians. As long as those communities exist and are important to us, their needs and capacities have to be factored into any overall strategy that is going to work. Further, as suggested below, the needs of those communities may be the key to developing more effective ways of increasing the conservation capacity of private land. (Fig. 3.)



Fig. 2. The once thriving town of Eucla, Western Australia—now a desert. We need to confront and turn around a legacy of land degradation that accumulates to the tune of about \$5 billion per year. (M. Archer).

For years I added my voice and writings to those of other Australians worried about the effectiveness of traditional conservation strategies and commitments. But because focusing on the doom and gloom of the past and present does little more than depress people who should otherwise be acting to change things, I've thrown my lot in with optimists who know it is critically important to overcome conservative reaction, to conceive new initiatives that could increase effective long-term conservation not only of the biota, but of rural and regional Australia as well. Many of these futurists contributed to the landmark publication *Conservation through sustainable use of wildlife* (Grigg, Hale & Lunney 1995) and maintain their commitment. That vital publication was the clarion call for the 'revolution' we continue to explore here.

Not surprisingly, suggestions for trials of non-traditional strategies provoke antagonism from some conservative groups. Much of this antagonism is based on presumed or imagined problems or the logical error of *false dichotomy*—i.e., the presumption that of two solutions to a problem, only one can be appropriate. I am told by some, for example, that my view that we need to value wildlife to increase our commitment to its future actually means I am suggesting we

abandon protected area strategies—which is an absurd non-sequitor. My focus is on the importance of trialing *compatible* conservation strategies that will act synergistically to increase the likelihood of achieving the overall goal. Protected area strategies, like ecotourism and other ongoing conservation programs, are essential *sine qua non* strategies that need to be augmented, not replaced. Similarly, in promoting the conservation and economic propriety of sustainably harvesting kangaroos, it is silly to suggest, as some do, that I am therefore also arguing that consumptive use is all we should do with kangaroos, or that we should abandon harvesting sheep, cattle and other introduced species. My argument is that sustainable harvesting of kangaroos on sheep- and cattle-properties can value-add to other conservation and rural and regional strategies. Arguments that we should trial native animals as companions similarly does not mean I am suggesting we abandon keeping Cats and Dogs. Decisions about which strategies are followed needs to be a matter for personal choice within the range of legitimate options. What I am trying to do is encourage a *broadening* of the range of options that might benefit the biota and rural and regional Australia.

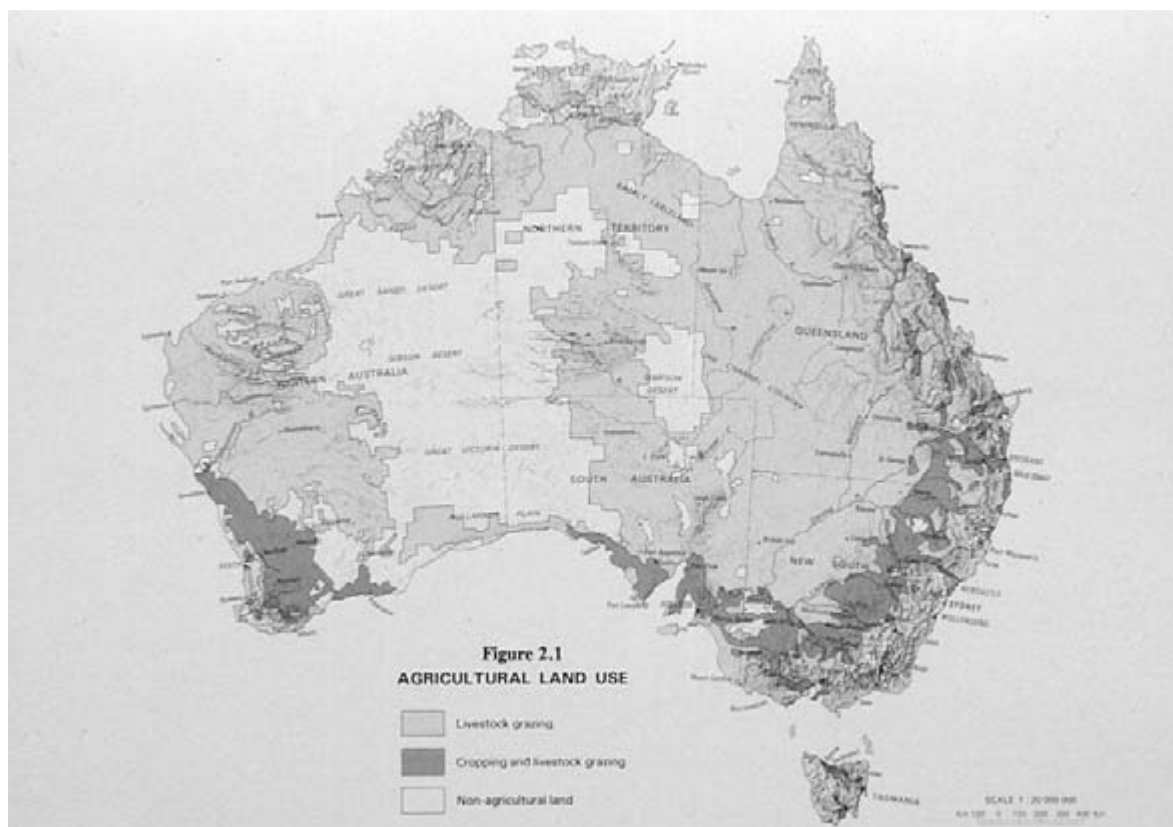


Fig. 3. The major use of private land in Australia is Agriculture which consumes and to one degree or another unsustainably degrades 65-70% of the continent. (Courtesy Nature Focus and Nature Australia).

It is my intention here to present an issues paper, not a technical treatise on these topics. Many of the papers appearing alongside this one were generated partly in response to these issues which I and others before me have raised for years and which more recently have become topics of sustained public interest. So while the pendulum of public interest and political commitment seems to be sticking closer to the rational side of its range, I want to spread these issues out for wider consideration.

Challenges to conservation from the perspective of deep time

Research that our palaeontological team has conducted over the last 25 years into the prehistory of Australia's lineages and natural environments has involved some 80 colleagues in 26 institutions and 11 countries. It is giving us an increasingly better grip on the importance of deep time understanding to provide key insights into conservation issues. By deep time, I mean a perspective framed in millennia and/or millions of years, rather than the brief two centuries and a bit since European colonisation of Australia. Ideally, we should anticipate change as far forward as we are able to document in retrospect. The further back in time we comprehend, the further forward

we can anticipate, wisdom advocated by many historians and biologists. Developing effective strategies for environmental sustainability requires knowledge about processes such as evolution, geological cycles and greenhouse/icehouse climatic cycles (e.g., as overviewed in McGowran *et al.* 2001) that converted the past into the present because these processes will continue to shape the future. (Fig. 4.)

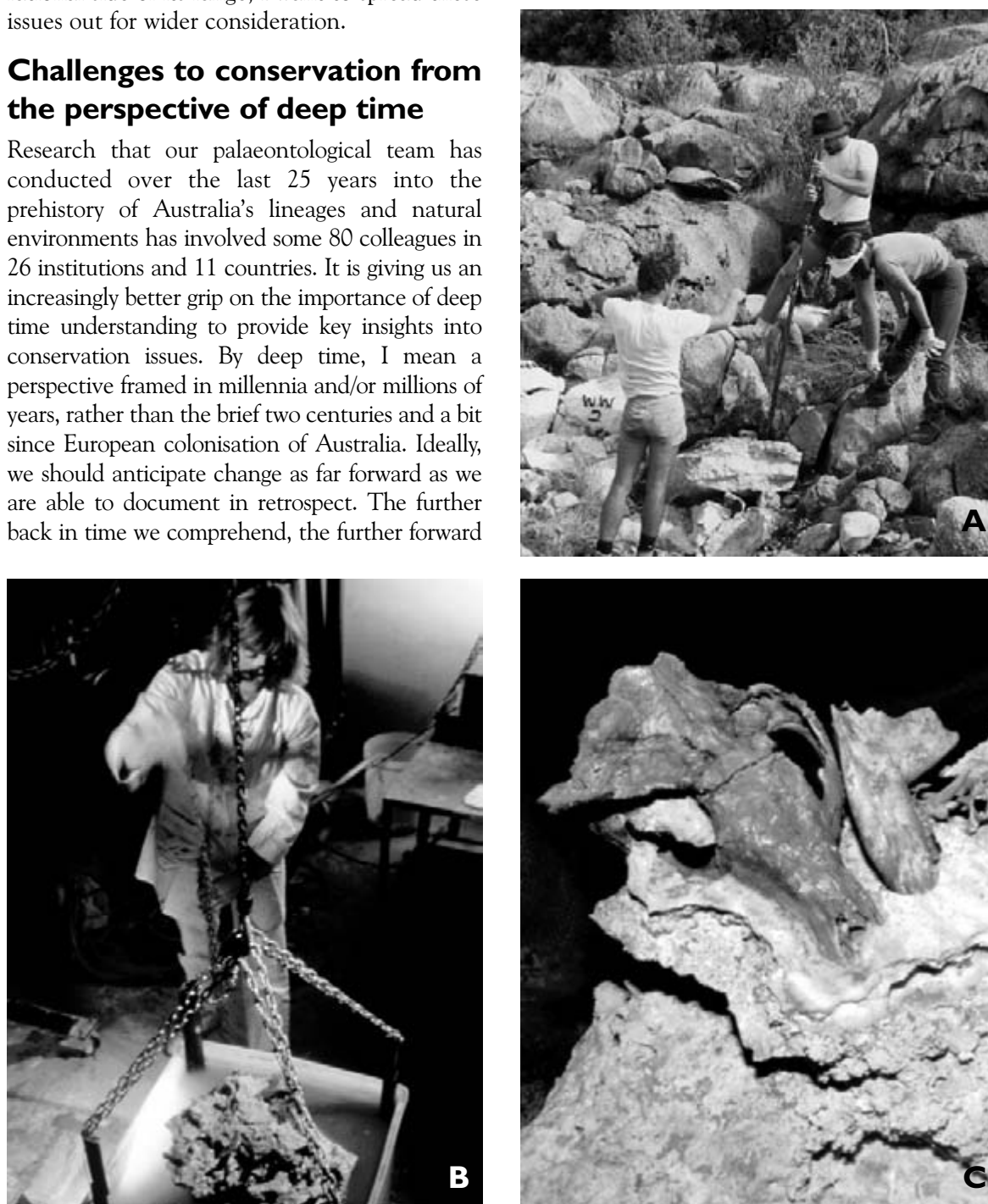


Fig. 4. The Riversleigh World Heritage property: source for conservation information in 'deep time'. A, excavations at Wayne's Wok Site, one of hundreds of sites producing faunas collectively spanning the last 25 million years of Australian history (S. Hand). B, Acid-processing a large block of fossil-rich limestone (M. Archer). C, Fox-size thylacine skeleton emerging from a middle Miocene block of cave limestone (A. Gillespie).



Fig. 4. D, Reconstruction of part of the biodiversity that would have characterised Riversleigh in the early Miocene about 23 Ma ago (Archer *et al.* 1994b; courtesy New Holland Press).

Key points relevant to conservation that have come out of our research and that of other palaeontologists, biogeographers, evolutionists and conservationists who operate with a deep time perspective, have been documented in other contexts (Archer *et al.* 1992, 1994a, 1994b, 1995, 1997, 1998, 1999a,b). While we have pioneered this view in Australia, others elsewhere are similarly exploring the importance of palaeontological data for conservation (e.g., Delcourt & Delcourt 1998, Graham *et al.* 1996, Houston & Schreiner 1995, Jackson & Overpeck 2000, Knudson 1999, McDonald & Chure 2001, Swetham *et al.* 1999).

Key among lessons from the past is the fact that effective long-term conservation requires species originations to, on balance, off-set or exceed extinctions. Long-term capacity of evolution to produce these off-sets, although circumstance- and group-specific, appears for mammals to require areas about 300,000 km² or larger. Islands at the lower end of this range with demonstrated long-term viability include New Guinea, Borneo and Madagascar. Islands smaller than this rarely if ever demonstrate long-term lineage conservation—at least for mammals. By lineages I mean endemic taxa at family-level (or above) such as wombats, dasyures, feather-tail possums or horses. Smaller islands can conserve endemic

genera and species but for periods on average proportional to island area—the smaller the island, the shorter the period. This is because the risks of lineage death and or ecosystem collapse from environmental disasters is, on average, inversely proportional to the size of the area.

Because protected areas (reserves, parks etc.) are islands within a sea of alienated (usually agricultural) land, they need to be large and resilient enough for effective long-term conservation. In Australia, as in most areas of the world, individual protected areas appear to be orders of magnitude too small for effective long-term conservation of mammals. The largest protected area in Australia established to provide conservation for lineages of distinctive Australian mammals is Kakadu at about 19,000 km². This is approximately the same size as New Caledonia which, although colonised from time to time by lineages of large distinctive vertebrates, inevitably loses them to extinction. It is also the same size as the area of bushland destroyed in one Australian fire, the 1939 Black Friday bushfire in Victoria. Clearly, as with oceanic islands, all other things being equal, the risks to the future of a land-locked reserve are going to be inversely proportional to its size. Environmental disasters are going to wipe out the conservation capacity of small reserves more frequently and more profoundly than large

reserves. While not certain that the first signs of disaster are already being seen in Kakadu, initial reports of worrying faunal declines (Braithwaite & Muller 1997) have been followed by more substantial evidence for serious long-term declines (Woinarski *et al.* 2001). (Fig. 5.)

Add to the risks of fire and other catastrophic events that can instantaneously obliterate the conservation capacity of small reserves, growing concern about geographic shifts in the climatic conditions required to maintain particular ecosystems incarcerated in 'island' reserves, and even the largest reserves such as Kakadu become in the long term little more than short-term refuges headed for inevitable obliteration. The Wet Tropics rainforests of the Atherton Tableland in northeastern Queensland formerly survived severe climate change by being able to 'migrate' eastwards during the height of the last arid phase about 18,000 years ago. When a similar or equally profound climate change occurs in the future, these great forests with their unique animals will have nowhere to go being surrounded on all sides by agriculture—we have stolen their ability to survive change despite declaring them to have protected status.

For effective long-term conservation of each of the five major terrestrial habitat types in

Australia (e.g., rainforest, sclerophyll forest, woodlands, grasslands/deserts, wetlands), each would need on average about 300,000 km² which adds up to 20% of Australia (1.5 million km²). At present, there is little more than 7.8% in protected areas (*fide* Environment Australia 2000; and Anon. 2000a) established for the purposes of conservation.

Finally, there is the 'health' of rural and regional Australia in terms of its people and communities. This is not the forum to discuss the scale or detail of these problems but broadly they echo the environmental situation: overall decreasing yields/ha of valued products as land degradation takes its toll; significant net increase over the last few decades in the amount of financial input necessary to get every dollar out of agriculture; growing risks, demonstrated globally, of catastrophic disease in crops and stock; global competition and unpredictable market-driven changes in crop/stock value; loss of commitment and abandonment of properties as debts climb and future prospects dim; and decline in self-esteem as accumulating damage to the land is increasingly blamed on agriculture. Consequent decline in rural/regional communities as a whole is something media-informed Australians seem to have accepted as inevitable and unavoidable.

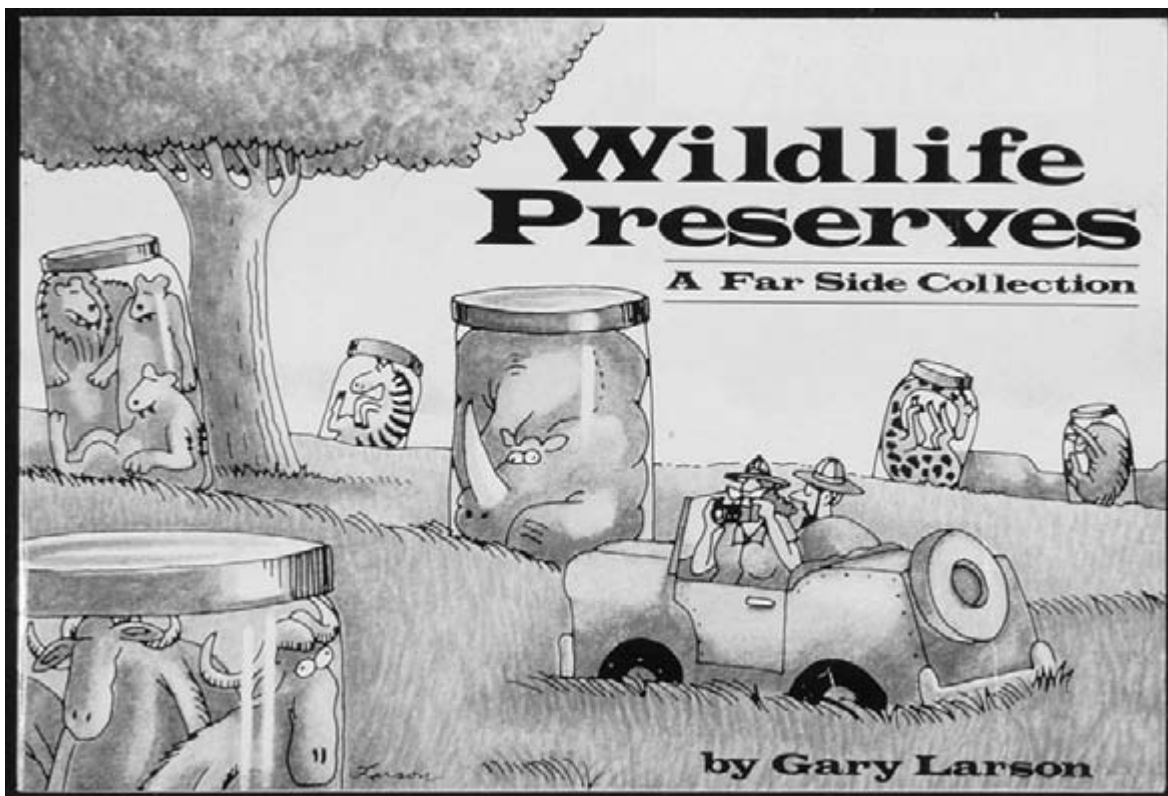


Fig. 5. Our protected areas, important in their own right, are not large enough to ensure a future for mammal lineages—hence they are more appropriately described as preservation than conservation areas. (Courtesy Gary Larson).

Valuing wildlife—an ancient and successful conservation strategy

We respond to claims of environmental degradation either by denying these are serious issues, resigning ourselves to inevitable loss, crossing our fingers in the hope that someone else will come up with a miracle fix, or fiercely determining to roll up the sleeves and join with other like-minded activists to turn things around. In the long run, none but the last will solve problems.

Already many groups share this fierce determination to do something positive about conservation including a wide range of government and non-government organisations. These include (there are many others) Environment Australia, Landcare, Bushcare, World Wildlife Fund, Planet Ark, Australian Conservation Foundation, Farmers Federation of Australia, National Parks at the State and Federal levels, National Parks foundations, Murray Darling Basin Commission, CSIRO, many university research programs and conservation centres, Royal Botanic Gardens, Australian Museum, land and water conservation agencies, Royal Zoological Society of New South Wales, Kangaroo Industry Association of Australia, Linnean Society of New South Wales, Australian Mammal Society, Biosphere Reserves, Nature Conservancy, Earth Sanctuaries Limited, Revive, private research groups, community groups such as WIRES, Frog and Tadpole Study Group, the Bilby Society, bush regenerators and fortunately many, many others. Collectively, these have had wonderful successes in tackling specific problems and engaging the energies of thousands who understand the urgency of the situation and want to help. These groups must continue to operate because each is contributing to the overall goal of conservation of either the biota and/or rural and regional Australia. They are all promoting compatible, conservation-focused initiatives.

However, as vital as they are, these efforts in themselves will not be enough or in time. We must find ways to significantly increase the amount of land with conservation capacity. It is, however, most unlikely and I think inappropriate that another 12% of Australia, the amount required to have conservation capacity beyond the 7.8% currently in protected areas, would be resumed from private ownership. In any case, resumption would exacerbate the economic/social problems of rural and regional Australia. For this reason, this extra conservation-capable land must be established through multiple use of existing private land that is 'healed' if necessary through restoration.

Here is where the major part of the zoological revolution required must take place—on private land, driven by private land owners working with advisory bodies that draw on all of the best, most far-sighted and in some cases bravest strategies available, looking for win/win solutions. To me the key change that must occur is to recognise the multifaceted *value* of native resources and that we can sustainably utilise specific resources to value-add to rural and regional incomes and in the process increase the conservation capacity of that same land.

In its most generic sense, there is nothing new about a focus on sustainable use of valued native resources. In the first place, it is what distinguishes the mindset of hunter-gatherers from that of the farmers—European colonists who cleared or damaged the native bush because they did *not* value it and introduced to more than 65% of the continent monocultures of non-Australian species which they *did* value. In Hugh Brody's view (Brody 2001), it is our southern Eurasian ancestors, the wheat-, cow-, pig-, goat- and sheep-farmers—not the indigenous hunter-gatherers—who are actually nomads because we over-populate using the agricultural surpluses we produce, damage land in the process, then wage wars on neighbours to take their land in order to continue to over-populate, and on it goes. But it is not *ad infinitum* because the amount of arable land is finite. And behind us abused land accumulates in a way that it would not have done when managed by the indigenous occupants of this land who valued, used and depended on its natural resources. Allowing the reality of the roots of modern agriculture and domestication having started in southern Eurasia (Diamond 1999), it is nevertheless interesting to speculate about the different global attitudes that might now hold sway if Australian Indigenous peoples had invaded England rather than vice versa—introducing kangaroos, emus and wattle seed to be farmed in an England they cleared accordingly of its unseemly native animals and vegetation. Of course, early English settlers did more or less the same thing to the original biota of England such that now the bulk of wild mammals that occur there are rabbits which were introduced to England. Native English species struggle to survive. Still, had history taken a different turn, they might now be combating plagues of brushtail possums and wombat warrens undermining their castles.

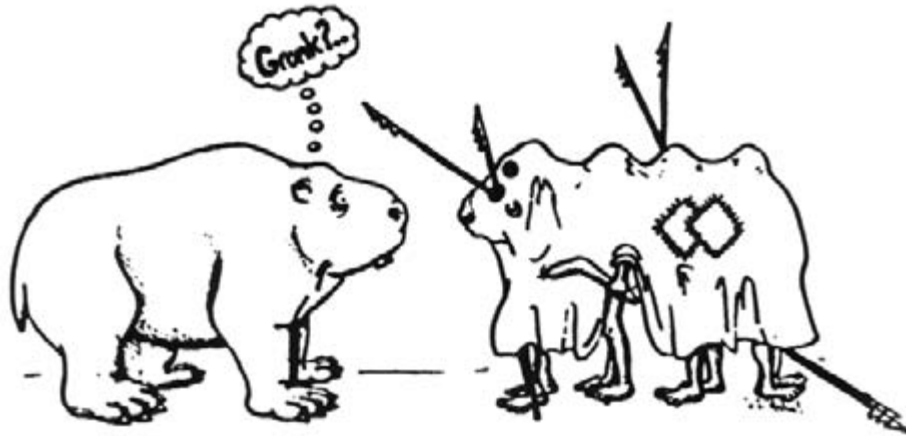


Fig. 6. Conflict continues about who or what killed most of Australia's megafauna during the late Pleistocene. Some have argued for 'blitzkrieg' by early Humans but this view is under challenge. (Courtesy Colin Stahel from Archer & Clayton 1984).

In the case of Australia, there are some who argue (e.g., Jones 1968, Merrilees 1968, Flannery 1990, 1994, Roberts *et al.* 2001) that the first peoples into Australia blitzkrieged the biota, exterminating its unique megafauna by about 46,000 years ago, possibly within 1000 years of the arrival of humans. This view is not universal and increasingly challenged (e.g., Field & Dodson 1999, Wroe & Field 2001). As more substantial evidence accumulates spanning the critical interval from 100,000-20,000 years ago, there is increasing evidence that humans and the megafauna in Australia overlapped by up to 25,000 or more years making climate change and/or a combination of factors (some probably anthropogenic) more likely than blitzkrieg as the cause for the late Pleistocene pulse of megafaunal extinction. Some megafauna, however, still survive in the form of Red, Grey and Euro kangaroos, Emus and Cassowaries.

This side of 35,000 years, however, most agree that the land management practices of Indigenous Australians, deliberately or inadvertently, secured hundreds of distinctive species of mammals many of which they valued, particularly as food and clothing, and sustainably utilised. In stark contrast, more than 30 of these went extinct or drastically declined within decades of the arrival of Europeans. Put into a global context, of the 60 species of mammals that have gone extinct throughout the world in the last 500 years, a third have been from Australia within the last 200 years. In New South Wales alone, 77 (59%) of the 130 mammals originally known to have occurred in this State are now classified as Threatened and 27 (21%) are Extinct. The precise reasons are the subject of constant debate. Beale & Fray (1990), Brody

(2001), Dickman (1993), Flannery (1994), Rolls (2000), Rifkin (1991), Low (1999), White (1997) and many others lay almost all of the blame at the feet of European land-clearing and introduction of non-Australian species. Lunney (2001) makes a particularly strong case that in at least the Western Division of New South Wales, the primary cause of the extinction of mammals was the introduction and spread of Sheep.



Fig. 7. Europeans have been responsible for the extinction of many species that Indigenous Australians lived with for at least 60,000 years, including the Tasmanian Thylacine.

To me, there is an important message here about the valuing system of Indigenous people in Australia—it worked until the arrival of Europeans. While some have suggested that traditional Indigenous culture is an anachronism most appropriately studied in books and as artifacts in museums because its time has passed (e.g., Sandall 2001), I would suggest that it has never been more timely and relevant than right now as a range of dynamic conservation strategies. Whatever remains of that valuing system should be revitalised and put back into practice before more species are lost. In terms of specific Indigenous land management practices such as patch-burning, its importance for conservation is now widely accepted. Similarly, the intrinsic value of Australian biodiversity for natural and cultural systems, continues to be recognised through ecotourism. We are also becoming very interested in the economic and human health benefits that could derive from the genetic capital of native plants (e.g., Beattie & Ehrlich 2001). What is less widely recognised or accepted is the enormous potential for further conservation and cultural gains that could (and I would argue *must*) be achieved through sustainable harvesting and other uses of appropriate native species—back to basics.

The second reason a focus on sustainable use of native resources reflects a view that is being increasingly advocated by conservationists frustrated by the failure of traditional strategies alone to conserve species and, in particular, to commit local communities to their conservation. Webb (1995) makes a very sound case for ‘CSU’, conservation through sustainable use. This view is also advocated by Sir Martin Holdgate as Director General of the IUCN (Holdgate 1992, 1996) and many others including McNeely (1988), Armstrong & Abbott (1995), Asafu-Adjaye (1995), Choquenot *et al.* (1995), Damm (in press), Davis (1995), King (1995), Wilson (1987) as well as by international, national and state authorities (see below).

Multifacets on the gem of ‘value’

The key to increasing success is to recognise that reliance on one strategy alone, no matter how venerable, will not achieve the goal of conservation. In our western agricultural view, the strategy most venerated is that of establishment of protected areas. Over the last 200 years, that has meant setting aside a chunk of land, commonly too steep to plough, rocky or

deficient in some way that makes it unsuitable for agriculture, building a fence around it, and then dedicating the surrounding ‘useful’ land to farming monocultures of introduced species (e.g., Pressey 1995; Lunney *et al.* 1997). The result is minuscule, non-sustainable islands of natural ecosystems within a sea of ‘de-natured’, degenerating land.

In contrast, the likelihood of winning the ‘game’ of conservation will be increased by use of multiple, compatible strategies—like the game of golf. Committing to just one kind of club is a sure prescription for failure; success urges a repertoire of compatible tools because the challenges faced will not all be the same.

I presume that conservation capacity, at least on a short-term basis, of managed protected areas is something we can more or less take for granted. This is not necessarily the view of some organisations such as Earth Sanctuaries which argue that traditional protected areas have reduced effectiveness because they retain introduced predators, but for me this is not the point. The point is that there is not remotely enough land for effective long-term conservation in all of the protected areas combined no matter what management strategy they employ. So the issue of the value of multiple conservation strategies needs to be focused first on *private* land—land managed in most cases for agriculture.

Considering private land, there are two main kinds presenting different opportunities: urban land, within and adjacent to cities; and rural land. While the amount of urban land is relatively minuscule, it is where most of us live and hence is important in shaping attitudes and nurturing commitment. It is also the coastal land and many conservation strategies now also focus on the increasingly urbanised coastal strip from Maroubra to Manly and beyond. I am not the first to argue that we desperately need to integrate the two to whatever extent we can. Strategically planned corridors of natural environment woven through suburbs, linking backyards to the bush, would do enormous good by introducing native bush-dwellers to human city-dwellers. Wildlife could wander through or establish in cities, making friends and converts to the notion that they have value and hence should be conserved. Integrated backyards with sustainable populations of wildlife would be a source of neighbourhood pride. Local Councils, assisted by Government, could reduce the rates of targeted families who agreed to commit their

backyards to native vegetation to create the corridors that made this possible. Backyard bush ponds where residents could swim with frogs and turtles could replace the environmental horror and expense of chlorine-poisoned giant bathtubs. Already there are many companies (e.g., Enviroswim) which could manage the environmental safety and health of such ponds without the use of chlorine. Houses could be built (as sensibly suggested to me by Nick Mooney) to incorporate ceiling to floor one-way glass 'terraria' that enabled residents to watch real possums play, mate and raise young rather than 'Big Brother' on TV. Perhaps most controversially, we could open the back door and let the wildlife in—either as visitors or native companions (more about this below). Potential opportunities for integrating the wildlife of the bush with the wild life of the city are limited only by imagination or legislation.

When it comes to rural private land, however, opportunities for innovative conservation strategies are far greater. I accept and endorse all of the ongoing strategies such as those promoted by Landcare (one in three farmers is a member of a Landcare group), Bushcare, WWF, Earth Sanctuaries and other Government and non-government organisations focused on

conservation initiatives. Similarly, the very bright initiatives for bioregional planning and commons-type cooperatives which are the focus of David Brunckhorst's research (e.g., Brunckhorst 2000) are wonderful shifts in a positive direction. All of these programs increase the capacity for conservation.

Initiatives focused on ecotourism are among the most important because they are driven and maintained by economic incentives both for the landowner and for the entrepreneurial manager. These have proved to be very successful incentives for conservation in Africa, Asia, North and South America and, to a lesser extent, Australia. The extent to which ecotourism occurs on private as opposed to protected land varies with, e.g., more private African than Australian wildlife sanctuaries involved. Also relevant, however, are ecotourism's potential negative impacts on environments involved. At a symposium in Pretoria in 2000 on the conservation benefits of utilising wildlife, several presenters acknowledged that long-term ecotourism had led to environmental problems because of increased tourist access and consequent damage to fragile lands and reproductive life cycles for iconic species such as Lions and Cheetahs, disruptive processes that had resulted in cubs being starved. One



"Don't be afraid, dear—it's a tree!"

Fig. 8. Private and public urban areas need living bridges to lead wildlife into our cities and our minds. Cities have often been described as places where after all the trees have been removed we name streets after them. (Courtesy Gahan Wilson).



Fig. 8b. Filling our urban gardens with native rather than introduced plants cuts down water and fertiliser use, helps intergrate the bush and the cities and introduces Australians to the beauty and value of Australian plants. (M. Archer)

comment was that ecotourism vehicles left tracks and ruts that were visible for years and turned Kenya's Amboseli National Park into a Disneyland during the tourist high season (Damm, in press).

Despite these concerns, overall experience suggests that environmentally-managed ecotourism should be tallied as a generally positive initiative for long-term conservation. This is the view sensibly promoted by Dave Croft (1999, 2000) and others (e.g., Braithwaite 2002, this forum) focused on the tourism industry. Suggestions that this is the *only* appropriate form of wildlife use, particularly on private lands, however, should be treated with some skepticism. Because Australian animals are on average smaller and less awesome than those in Africa, and most are predominantly nocturnal, ecotourism interest in Australian mammals at least is likely to benefit a far more limited proportion of the rural/regional community than it does in Africa. It is questionable how many ecotourists would be willing to spend serious money to watch three or four kinds of conspicuous kangaroos sit in the shade under a tree. Nevertheless, it is a benefit and should be promoted.

These relatively non-controversial, compatible conservation strategies are not, however, the only ones that should be on the table for consideration. Harkening back to Indigenous strategies that have long-term conservation benefits, both here and overseas, we should also be exploring the potential advantages of sustainably harvesting, hunting and perhaps even farming of native wildlife. As Brechin *et al.* (2001), Beale (1999), Damm (in press) and others have pointed out, reliance on protected area strategies is not having the wins globally and in Australia that advocates expected—to do better, we need to explore innovative, compatible initiatives that could increase the conservation capacity of private land.

Sustainable harvests of value

Sustainable harvesting of native species for food, medicine and other valued products has been practised continuously by Indigenous peoples for thousands of years and by Europeans on and off for centuries. The modern focus in Australia on this strategy as a way of increasing effective conservation achieved through other means has been pioneered by many since the 1970s. Grahame Webb in particular has promoted and put into practice sustainable harvesting programs focused on native species. Webb (1995) notes that 'CSU', conservation through sustainable use, is '...just another conservation strategy—an

additional tool that can be used by wildlife managers to solve wildlife conservation problems. It is particularly well-suited to enhancing conservation on private or communal lands outside of national parks, reserves and protected areas'. The significance of this is that 95% of the land surface of Australia and the rest of the world is not in parks, reserves or other kinds of protected areas.

1. Sustainable harvesting of kangaroos

In Australia, the existing kangaroo industry is more than 30 years old and is demonstrably sustainable in so far as the number of individuals of each of the species harvested has on balance grown in the interval since the industry began with all being among the most numerous of large mammal species in the world. Advocacy for the sense of this sustainable harvest has long been promoted (e.g., Wilson 1974, Grigg 1984, 1989, 1995, 1997, 2002, Sattler 1995) although there are some (e.g., Pickard 1990) who reasonably argue for more data that would clarify or test the hypothesised conservation advantage before assuming this outcome.

The health benefits of eating kangaroo are well-known (e.g., studies by the CSIRO Division of Human Nutrition) and include lean, very nutritional and tasty meat which if cooked correctly can match the tenderest beef despite having less than 2% fat—most of which is polyunsaturated or monounsaturated and low in cholesterol. The meat is also relatively free of human disease with proportionately fewer kangaroo carcasses being rejected at the processing plants than cattle or sheep, despite more intense inspections (J. Kelly, pers. comm. 2001). This reflects the fact that kangaroos are marsupials with collectively 200 million years of evolutionary distance between them and us and therefore significantly reduced likelihood of shared parasites (e.g., there is no such thing as 'mad kangaroo disease'). As the rest of the world begins to worry about farming cattle, sheep and pigs (all placental mammals related to us), sustainably-harvested free-range kangaroo is increasing in international as well as national appeal.

To whatever extent graziers could shift from total dependence on raising cattle and sheep with their attendant economic and health risks, and commit part of their grazing lands to native bush with sustainably harvestable kangaroos (and other resources such as appropriate plants), there should be benefits in all directions. Kangaroos would gain in population size, distribution and

security through being valued by graziers instead of being regarded as pests that compete with their stock. No mammal that has become the focus of agricultural interests has gone extinct. Non-target species should benefit (although this needs to be tested rather than presumed) because the grazer needs healthy biodiverse bush to sustainably produce the harvestable native resources. Grigg (e.g., 1997) has described the benefits that would come from reducing sheep numbers in favour of kangaroos on the rangelands as 'sheep replacement therapy'. The grazer gains because of the potential for sustainable value-adding incomes and a broadening of the resource base making their overall incomes more resilient to environmental or market disasters. The consumer gains because they have a wider range of healthy products available to them in the markets. The economy gains because of an increase in unique Australian products, market resilience and greater stability in the rural/regional sectors. Despite sharing financial benefits with graziers, even the kangaroo industry should gain because of a rise in consumer interest (driven by increasing public awareness of the conservation value of sustainably harvesting native wildlife) and in the volume of marketable product as more land is valued as animal-rich bushland.

An interesting experiment is taking place on Mulyungarie Station, a 3300 km² pastoral property in South Australia owned by the Mutooroo Pastoral Company (Hoy 2001). Aerial surveys conducted by university teams demonstrated that there are 165,000 Red Kangaroos on the property—the equivalent in terms of grazing pressure to 110,000 sheep. The Station's overseer, Richard Gloster, understands these Reds to be a sustainably harvestable resource and that they are '...as valuable in the paddock as sheep'. Each year they have been harvesting for profit an average of 8,000 to 10,000, mainly males with an average weight of 40 kg. Ongoing surveys by the University of New England over the last eight years have demonstrated that the number of kangaroos on this station has increased from 20 to 50 per km².

Recent modeling of harvesting strategies in place (McLeod 2001) indicate that it would not endanger any of the species involved—in fact quite the opposite. Because harvesting which focuses primarily on males increases the proportion of breeding females in the population, and because only one male mates while the other non-mating individuals consume resources, the percentage of

reproductive individuals in the population actually increases. Suggestions that somehow the genetic composition of the population will be significantly altered by harvesting has been disputed by geneticists (Hale 2001) who argue that for populations of species such as Red Kangaroos where the numbers are in the millions, harvesting on the scale conducted by the kangaroo industry could not possibly affect the genetic balance of the species. Research by Wilson (1988), Pople & Grigg (1998), Pople *et al.* (2000), Grigg (2002) and authors cited therein similarly support the biological and economic viability of the industry.

Suggestions that shooters preferentially targeting large males will alter the population structure and survival capacity of kangaroos (Croft 1999) fails to consider that for at least the last 60,000 years Indigenous Australian hunters also would have maximised their chances of a successful hunt by targeting the large males with no apparent ill-effects—Red Kangaroos, for example, have been around and sound for at least two million years. The kangaroo industry probably contributes to the restoration of the traditional pre-European balance.

Animal rights advocates claim cruelty is an inherent part of the industry and that this is a reason to stop sustainable harvesting. Many others before me have pointed out the seriously misleading and frequently dishonest nature of these claims (see in particular Hopwood 2001). Hoy (2001) points out that a central part of a major campaign by animal rights advocates was a video purporting to show the kangaroo industry at work—with acts of cruelty involved. But their campaign was dealt a serious blow when German courts convicted the film-maker Michael Born of fraud. They found he had in fact fabricated the footage. The 'hunt' had been staged in 1986 for the camera and conducted by an unlicensed shooter who did not have permission to hunt on the property, did not have a gun licence, had nothing whatsoever to do with the kangaroo industry and has since been prosecuted. Evidence was presented that he had been actively encouraged by the animal liberationist film group to commit the acts of cruelty which they then filmed, having also convinced him that they were from an American game shooting magazine. This bizarre fabrication was then used by animal liberationists to persuade British supermarkets that they should not stock kangaroo meat because this was a demonstration of how the industry operated.



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Fig. 9. Animal rights groups such as Viva!, whose English founder and Director Juliet Gellatley is pictured on the front page of the 19 July 2001 issue of the The Land (with a decidedly ambiguous headline), infuriate graziers and rural communities with emotive arguments that all kangaroo harvesting should stop immediately because it is cruel and inappropriate. (Reproduced with permission.)

The reality is that the vast majority of kangaroos culled are head-shot (>98%; confirmed by recent surveys conducted on behalf of Environment Australia and the Australian Royal Society for the Prevention of Cruelty to Animals), by TAFE-accredited harvesters, at night while the animals graze resulting in a quick, unanticipated and relatively painless death. But beyond this, it is important to acknowledge that if a kangaroo is not harvested in a humane manner, it will die an

unquestionably painful, stressful and prolonged natural death either from starvation or predation—they are not, as many of us would otherwise like to think, immortal. Sustainable harvesting of free-range herbivores has been acknowledged by Peter Singer, advocate for many animal liberationist organisations, to be far less stressful to herbivores than mustering, yarding and finally road transport to abattoirs. This is a shared view that has been expressed by the RSPCA: 'If achieved correctly,

kangaroo culling is considered one of the most human forms of animal slaughter. An animal killed instantly within its own environment is under less stress than domestic stock that have been herded, penned, transported etc.’ (RSPCA 1985).

2. Sustainably harvesting other species—animals and plants

Currently very few native species are sustainably harvested for meat and that may always be the case. The point is not to find human food value in *everything* native—rather in a few relatively robust species, such as some kangaroos and emus, that can sustainably provide the economic incentive to repair or secure more natural bush which in turn will enhance the survival capacity of millions of other species that most of us do not even know exist.

Obviously conservation and economic benefits can also flow from a focus on sustainably harvesting appropriate native plants for a range of potential reasons including decorative flowers, garden plants, medicines and food. Examples of food include the seeds of various Wattles (*Acacia* spp), the delicious blueberry-like fruits of Midyim (*Austromyrtus dulcis*), the prince of nuts obtained from Macadamia trees (*Macadamia* spp.), Bunya Pine seeds, the wide range of fruits and other products from native Figs (*Ficus*), exotic Davidson’s (*Davidsonia pruriens*—which also makes a fine wine), Illawarra (*Podocarpus elatus*) and Kakadu Plums, Bush Tomatoes (*Solanum centrale*), Quandongs (*Santalum acuminatum*), the tasty fruits of Lillipillies (*Syzygium australe*), Wild Limes (*Citrus australis*), Wild Rosella, etc.—the list is delightfully long (regularly discussed in *Australian Bushfoods Magazine*). Other reviews of native plant bushfoods in Australia include Bruneteau (1996), Cherikoff & Isaacs (1991), Graham & Hard (1997), Isaacs (1996), Latz (1995), Low (1991), Roberts *et al.* (1995) and Stewart & Percival (1997).

Many brightly-coloured native flowers and foliage are also sustainably harvestable resources (Brunckhorst *et al.* 1999), sometimes appreciated by others first—e.g., New Zealanders who are currently marketing Australian Waratahs as ‘New Zealand Roses’, grabbing market advantage as they cheekily did by marketing Chinese Gooseberries as Kiwi Fruits.

Native plants are also valued for building materials such as Broombush (*Melaleuca uncinata*) for fencing and many native hardwood timbers used for building and fine furniture such as Cypress Pine, Mulga, Gidgee, Ironwood, Beefwood, Red Gum, Leopardwood and Rosewood. There are many organisations, such as

the Australian Forest Growers Association, focused on sustainable harvesting of native trees rather than introduced species such as *Pinus radiata*. The planting of progressively harvestable stands of native timbers on private land, as an investment, is another strategy that can have enormous financial and environmental benefits.

3. Sustainable harvests for medicinal purposes

Of potentially very high value are the many native species with medicinal properties. Among animals recently examined, exciting new families of fungicides from frogs and antibiotics from Koala pouches and ants (Beattie & Ehrlich 2001) and even marine molluscs (Benkendorff 2002, this volume). Plants with medicinal value include Lemon Myrtle (*Backhousia* spp), Tea Trees, Native Mint (*Prostanthera rotundifolia*) and Peppermint, all of which are reputed to have anti-microbial activity, Mountain Pepper (*Tasmannia* sp.) being studied for its antifungal properties, Prickly Fanflower (*Scaevola spinescens*) being tested for antiviral, antitumour and other significant activities, and the Moreton Bay Chestnut which besides producing exquisite furniture wood produces castanospermine which is being investigated for its potential in the treatment of AIDS. Reviews of potential or realised medicinal value of native plants include Cribb & Cribb (1981), Lassak & McCarthy (1983), Low (1990) and Armstrong & Abbott (1995). Undoubtedly only the tiniest fraction of native plants and animal compounds have been tested for potential products of value.

4. Intellectual property rights to ethnoecological knowledge

There is an enormous amount of Indigenous ‘ethnoecological’ knowledge in this area (e.g., Warren 1992, Nations 1992, Latz 1995, Roberts *et al.* 1995). For example, the healing properties of Prickly Fanflower have long-been extolled by Indigenous Australians. Programs initiated now to capitalise on the food or medicinal properties of native species previously known by Indigenous Australians to have these values need to recognise and acknowledge traditional intellectual property rights, a moral issue that has been well discussed elsewhere (e.g., McNeil & McNeil 1989). International efforts to record, store and declare Indigenous knowledge have involved establishment of networks of resource centres (e.g., CIKARD, LEAD, CIRAN, INRIK). Australia needs to do the same thing rather than continue to allow this topic to be developed in an *ad hoc* manner by individuals with varying degrees of commitment to recognising Indigenous rights in this area.

Hunting for other reasons

Apart from sustainable harvesting for food, there are other hunting strategies that could increase the conservation capacity of private rural land such as hunting for sport and/or hunting as a tool for pest control (e.g., King 1988, King 1995, Marks 1994, Choquenot *et al.* 1995, Allen *et al.* 1995, Asafu-Adjaye 1995, Falkena 2000, Damm *in press*).

1. Hunting native species for sport & profit

Hunting kangaroos for sport, while once common in Australia, is no longer sanctioned. Yet hunting native animals for sport is the basis for major industries on other continents such as Europe, North America and Africa with the added advantage of increasing the value and impetus to conserve native habitat. Examples include sport-hunting programs focused on deer, grouse and many African mammals. Through this process, private land owners commit to maintaining viable native habitat because they receive a sustainable income from those who pay to hunt. In Australia there are established enterprises of this kind focused on the hunting, with a licence issued by the relevant wildlife authorities, of ducks, fish, some kangaroos and other native species on private land. Commercial fishing industries in freshwater and marine environments are too well-known to need further comment.

2. Hunting of introduced species for sport & profit

Perhaps more relevant to contemporary Australia are programs and industries focused on the hunting of introduced pest species such as pigs, various species of deer, foxes and water buffaloes. Already many land owners charge for the right to hunt pest species on their property. Industries, clubs and magazines are growing up around pig-hunting in many areas of Australia such as Queensland. When collecting fossils near Charters Towers years ago I was told by the station owner that hunters were happy to pay him many hundreds of dollars to shoot a single Spotted Deer which were in plague numbers on his property. While this has the conservation advantage of reducing numbers of feral animals in native habitats, it also has the risk of encouraging maintenance of these species *because* they provide a revenue stream. For this reason, it might be better to eradicate the introduced species and follow this with sustainable hunting of the kangaroos whose

populations would probably increase in response to the reduction in total grazing pressure.

Unfortunately eradication of introduced pests as a way of advantaging the native biota is often obstructed by animal rights groups (e.g., Singer *et al.* 1991). King (1988) notes the regrettable situation on Round Island near Mauritius where animal liberationists hampered eradication programs focused on feral animals, this interference resulting in the extinction of native species. Animal rights groups in Australia have similarly challenged the propriety of eradication campaigns focused on removing introduced species from Australian parks and protected areas. Animal rights campaigns to stop the fur trade in foxes, an introduced carnivore in Australia that causes major environmental damage (e.g., foxes ate all captive-bred and seriously-endangered Numbats when they were released into the wild, leaving only the radio collars), has led to more extensive use of 1080 to control their numbers thereby putting more native animals at risk. If animal rights advocates were really serious about the welfare of Australia's unique and endangered animals, they too would advocate extermination or rigorous control of all introduced species, feral foxes, cats, dogs, horses, camels, rabbits etc., by whatever means are available.

Farming native species?

While sustainable harvesting of free-range kangaroos or other suitable wildlife most closely emulates traditional, environmentally-friendly strategies, *would* it be that outrageous to consider the possibility of farming native species as an alternative to farming introduced species? Clearly this is much stickier question fraught with many 'what ifs' including the temptation for some to breed for traits in the animals—or plants—that might make them more profitable or efficient to manage. However, hopeless kangaroos, stumpy-legged emus or rainbow-coloured Waratahs would be of distinctly limited conservation value and hence not goals I would advocate.

The primary advantage of farming native species, ideally in their present form, would be reduction in the number of environment-damaging introduced species such as hard-hoofed ungulates like sheep, cattle and goats that crop lower, pulverise and excrete less viable native seed, produce mazes of anastomosing trails and cut up the fragile soils allowing more of this natural asset to turn to dust than would be likely to occur with kangaroos (e.g.,

discussed by Grigg 1989, 2002). In terms of plants, Eric Rolls pointed out to me that there are many native grasses such as Curly Mitchell Grass (*Astrelba lappacea*) that was said to have ‘ears nearly six inches long, well-filled with a clean-looking firm grain’ and it may have been this species that was used to supplement meagre rations of wheaten flour during WWII. Native Millet (*Panicum decompositum*) is another native grass that was favoured for bread-making by Indigenous peoples. These and many other native plants such as Oat Grass (*Themeda avanacea*) may have the potential to be broadacre-farmed for profit, hence conserving through valuing a native species rather than clearing the natives to farm introduced species. Further, it is entirely possible that being native these species would be more resistant to diseases, droughts and other environmental challenges that for millions of years were part of the evolutionary forge that produced them.

On the other side of the ledger with farming would be reduction in gains that come with free-range harvesting, both in terms of native animals and plants, and the incentives to preserve their natural habitats. Farming animals or plants of any kind normally involves confining them as monocultures to paddocks or fields without the need for healthy bush to support them.

Native companions

Few conservation initiatives seem to stimulate as much debate and hot air as that of native animals as pets or companions (e.g., Vasquez 2001; Viggers & Lindenmayer 2002; Hopwood 2001). My promotion of this initiative is based on seven issues:

1. my own and others’ personal experiences over the last 35 years companionship a wide range of native animals;
2. convictions by other zoologists about the importance of being able to keep native animals as a way of obtaining information critical for their conservation;
3. convictions by other zoologists (and botanists) about the importance of keeping native species as a compatible way of minimising the risks of extinction;
4. concerns about the extent to which Australian children are increasingly unfamiliar with and hence not driven to conserve native animals;
5. concerns about the sometimes fatal diseases we know humans can catch from dogs and cats;
6. the reality that native Australian animals are being kept successfully as companions outside as well as within Australia;
7. and profound concerns that more ‘pets as usual’ will only exacerbate the rate at which native species are disappearing.

Personal experience

I did not set out to be an advocate for native animals as pets—it just happened. As a lover of all animals and PhD student in the late 1960s focused on the phylogenetic systematics of carnivorous marsupials, a friend offered me the chance to raise at home a laboratory-bred baby Chuditch or Western Quoll (*Dasyurus geoffroii*). The experience quite simply changed my life. At the time I lived in a Perth flat, with two Domestic Cats, the only animals I thought at the time to be suitable as flat pets. I did not know about the lethal risks of Toxoplasmosis which is commonly carried and communicated to marsupials by Cats—but nothing happened to this Quoll so perhaps these Cats were ‘clean’. Suffice it to say that over the next six years the relationships that developed between that Quoll, me and all others who came in contact with him was catalytic.

He was obsessively clean, never failing to use a box of kitty litter for all excretions, dog-like in his love of play throughout his life (*viz* Ogdon Nash: ‘The trouble with a kitten is that; Eventually it becomes a cat’), bright and quick to learn, far more affectionate and attentive than a Cat, intently curious, happy to play on his own but clearly happier to play with me, active particularly in the late afternoons and evenings and asleep at more or less the same times as me (one early morning activity period overlapped with my sleep but play-tussling with a hand kept him happy), puppy-like when playing even as an adult, careful to mouth without biting, content to fall asleep in my lap, generally very quiet with only ‘purring’, clicks or ‘Nark!’ sounds rather than yowls or barks, no ‘spraying’ or other stinky habits, and generally fascinating. Although as a youngster he was often bullied by the Cats, as a Cat-sized adult he was more than a match for them and they soon learned to leave him alone. When I moved to Brisbane I let him out into the backyard, as one would a dog or cat, and he freely came in and out of the house. Sadly, on the second evening, he mouthed an introduced Cane Toad (*Bufo marinus*) and died in my arms 20 minutes later from bufotoxins, at the middling age of 5.

That tragic loss of my special spotted friend was just the beginning for me of many years raising and interacting with a wide range of native mammals in domestic situations. While not all proved as suitable for flats or houses as that Quoll, most proved to be very affectionate, interactive and highly tractable—often as or more rewarding as companions than Dogs and far more so than Cats, although I allow that for some people, an attentive pet is not what they want. These native animals, some close companions for nearly 12 years, included Squirrel Gliders (*Petaurus norfolkensis*), Yellow-bellied Gliders (*P. australis*), Fruit Bats (several kinds), Ring-tailed Possums (*Pseudocheirus peregrinus*) and many others. These are social species that rapidly bond across species boundaries with instinctive behaviours such as head-rubbing in Gliders that in natural populations establishes and reinforces social cohesion within family units—they declared in head-rubbing the back of my neck

that they enthusiastically accepted me as a member of their immediate family even though I must have seemed a rather ugly possum.

Although I have also had Swamp Wallabies (*Wallabia bicolor*), Nailtail Wallabies (*Onychogalea unguifera*), Rufous Bettongs (*Bettongia rufescens*) and Brushtail Possums (*Trichosurus vulpecula*) as house companions, each had a downside. While the Swamp Wallabies were very affectionate and interactive day and night, they were also rather messy house guests. Rufous Bettongs and Nailtail Wallabies were too rough when playing and Brushtail Possums, while great as youngsters, could not resist nibbling toes when they became adult. Each, however, would have been fine in large, suitable backyards, or as visitors in the house, able to live outside.

Other smaller mammals, such as Mountain Pygmy-possums (*Burramys parvus*), Kowaris (*Dasyuroides byrnei*), Phascogales (*Phascogale tapoatafa* and *P. calura*) and many native rodents including Hopping Mice (*Notomys* spp.) and Rock-rats (*Zygomys argurus*), were a delight and success when maintained in ventilated terraria or large wood/screen cages that I made for the purpose. The incredibly beautiful native rodents were regularly handled by my small children with no risk of biting in contrast to the far more odoriferous and sometimes nippy introduced House Mice (*Mus musculus*). Other small mammals such as Antechinuses (*Antechinus flavipes*), Dunnarts (*Sminthopsis* spp) and Planigales (*Planigale ingrami*) were too ‘highly strung’, never seeming to settle down or



Fig. 10. Keeping native plants in our homes and backyards, rather than introduced plant species, helps to bond children to the importance of Australia’s unique creatures. Both the Western Quoll (*Dasyurus geoffroii*) and Swamp Wallaby (*Wallabia bicolor*) have been house guests of the author. (M. Archer)

suppress the urge to bite when handled. Antechinus allowed to run free in and out of the Brisbane house, however, were fantastic cockroach removalists!

In all cases, tractability was enhanced through regular interactions with the native mammals as youngsters but also enhanced in adult mammals with regular attention. Meeting these needs is certainly no greater than meeting the same needs in Cats and Dogs. When I compare my own and the attempts of others to settle down feral adult Cats (forget it) and Dogs (rarely successful) with attempts to do the same with wild-caught adult marsupials, the latter are far more likely to respond positively.

To those who argue (e.g., Viggers & Lindenmayer 2002) that Australia's native mammals exhibit '...limited interactive behaviour with humans and lack of domestication (including behavioural problems)...' and that a native animal pet industry '...will not produce animals that are viable substitutes for existing domestic pets...', I can only say that these remarkable conclusions must reflect preconceptions or very limited personal experience with Australian animals as companions. I would similarly repudiate arguments that my experiences may somehow be unique and therefore irrelevant to others interested in keeping native animals as companions because of the many similar experiences others have reported to me and discussed in the literature.

Based on my own experiences and those of others, suitability of some native animals as companions is incontestable. In areas where some can be kept legally, such as Hopping-mice (*Notomys*) in South Australia, the programs have been demonstrably successful. In many cases, native animals are as or better-suited than Cats, Dogs and Mice despite the thousands of years of companionships we have had with the latter three. The fact that Cats, Dogs, Mice, Rats, Rabbits, Ferrets, Lambs, Horses, Calves, Chickens and a host of other introduced species are defended as the only appropriate companions for humans reflects an arrogance that ignores the geographic accidents of history. If colonial humans had evolved first in and spread from Australia rather than Africa/Eurasia, I have little doubt that views about appropriate animal companions (and foods!) would be very different than those we now inflict on Australia.

2. Important information obtained by naturalists about native species studied at home

A lot of what we have learned in the past and need to know in the future of relevance to conservation biology has come from 'natural historians' who have kept these animals at home. This is particularly true for reptiles and amphibians. Allen Greer, a herpetologist in the Australian Museum, suggests that a great deal of what we know about Australian reptile behaviour and reproductive biology has been produced in this way by amateurs. The same principle is also true for other groups such as insects, fish, amphibians, birds and mammals. For example, before I kept a live Western Quoll, no scientist was aware of the almost unbelievable reproductive anatomy and behaviour of the males. I published these (Archer 1974) and other observations about the 'hard-wired' biology and behaviour of marsupials that had not emerged from centuries of study of pickled beasts or shadowy creatures seen at a distance in starlight. The same flow of information useful for conservation has probably resulted from the breeding and study of native Australian plants in private collections but this is an area with which I am less familiar.

3. Safe harbours for species threatened with extinction in the wild

How many species or distinct taxa now extinct in Australia might still be with us if we had taken them in as companions, even while we were destroying or significantly altering their wild habitats or unsustainably persecuting them in the wild? I cannot help but wonder whether the Thylacine (*Thylacinus cynocephalus*) would now be extinct if early settlers in Tasmania had made a serious effort to keep this magnificent animal as a domestic companion instead of just Dogs. From Col Bailey's investigations and Bob Paddle's research, clearly at least some became tractable even after being injured as subadults in traps (Paddle 2000, Bailey 2001). Similarly, although there are arguments about the survival elsewhere of the freshwater Lake Eacham Rainbow Fish (*Melanotaenia eachamensis*) once common in Lake Eacham on the Atherton Tableland of Queensland, it is now clear that because of the interests of aquaculturists descendants of the nevertheless highly distinctive Lake Eacham form thrive in hundreds of aquariums throughout Australia (including my own in the Australian Museum!) despite having completely disappeared from

Lake Eacham itself. Reintroduction of native freshwater fish from captive stocks damaged by abuse of river systems has been an active conservation strategy for other species (Cadwallader & Lawrence 1994) such as Golden Perch (*Macquaria ambigua*) and Murray Cod (*Maccullochella peelii*). And again, because of the interests of aviculturalists, many species of distinctive Australian birds have guaranteed futures in breeding colonies not only here but in many areas of the world, a security against extinction in the wild. While some would argue that if a species survives only in captivity, it is effectively extinct, I think this is an absurd view and one most unlikely to be shared by the species themselves. As self-determined custodians of Earth's biodiversity, we have a moral as well as a selfish responsibility to minimise the loss of that biodiversity. The more thriving colonies there are of any creature, animal or plant, captive or wild, the less likely that creature is to disappear.

4. Out of sight, out of mind—the importance of 'bonding' through close & constant contact

I worry that our kids are losing interest in the importance of Australia's native animals—and plants for that matter. Before and during colonial times, children were surrounded by

native creatures. Story-tellers wrote uniquely Australian yarns with them as the main characters and in many ways, our lives depended on them—so we *valued* them. That was then. Last year, I asked children between 5 and 10 years old in a large Sydney shopping centre on a Saturday morning to name ten animals. Of the 40 who responded, 85% failed to mention a single native animal. They were bristling with Cats, Dogs, Cows, Elephants, Zebras, Tigers, Lions, Rhinoceroses and other animals of the kind they either lived with, saw on television, read about in books, or stared at in the Zoo. They maintain keen awareness in particular of the introduced Dogs and Cats they live with and regularly encounter. But of the ones that even mentioned a native animal, it was a generic rather than specific response. For example, the only child who mentioned kangaroos listed *the* 'Kangaroo' when there are in fact over 53 different kinds in Australia alone. There is here, I think, an important message. Our children, the generation we expect to maintain a focus on conservation, may be losing awareness that distinctive Australian creatures exist and, if that awareness declines, so inevitably will the sense of value or concern for their future.



Fig. 11. One of the arguments in favour of keeping native animals as companions is the bonding nature of the experience. It is probable that the capacity for humans to contact cetaceans in captivity has contributed to the growing global commitment to conserve them. (Courtesy Dolphin Research Centre and S. Hand)

This view is shared by many others including responsible companies like Cadbury which introduces kids (and adults) to a vast range of Australian native animals, living and extinct, as coveted collectables inside their Yowie series of chocolates. While this primes their interest, if *live* native animals are not allowed to come close enough to capture the hearts of children, children will be less likely to allow them space in their hearts. Close contact with marine mammals in oceanariums has gone a long way to committing most humans to the love and hence conservation of whales. In a similar way, having native animals as companions would go a long way to committing Australian children to their novelty and need for conservation.

5. Relatively low risk of diseases shared between humans and Australian native animals

There has been speculation about dangerous diseases we might get or communicate to native animals if we had these rather than Cats and Dogs as companions. First, some evolutionary reality checks. The mammalian companions we now keep closest to us such as Cats, Dogs, Rats, Mice, Ferrets, Rabbits, Cows, Sheep and Pigs, are placentals, the same group to which we belong. As noted above, marsupials and placentals split from a common stock over 100 million years ago giving a combined minimum of 200 million years of evolutionary divergence between the two groups. It is inevitable if regrettable that we would share more diseases with our placental relatives than we would with marsupials. And that is what the medical record shows (e.g., Basile 2001, Reithinger 2001). Dog communicate to humans a wide range of serious diseases including Hydatid Tapeworms (*Echinococcus granulosus*) which can lead to nasty, sometimes fatal cysts in many parts of the body including the brain), Rabies (not yet in Australia [although similar to Bat Lissavirus], but for how long?), Leptospirosis (serious parasitic infection, also carried by some rodents), Flesh-eating Bacteria (*Leishmania infantum*) which can lead to chronic loss of bodily tissues through zoonotic visceral leishmaniasis, visceral Larva Migrans, Giardia, Ringworms and many others. From Cats we are known to get serious and sometimes fatal diseases such as Toxoplasmosis (*Toxoplasma gondii*), which can kill or deform children in the womb and lead to death in adults, and Cat Scratch Fever which although normally a simply treated illness has been correlated with encephalitis, hepatitis, pneumonia and other serious illnesses and is potentially fatal in

people with compromised immune systems. Relatively recent discoveries include that keeping Cats with kids can increase by 25 times the risk of their developing rheumatoid arthritis if there is a family history of the problem (Hood 2001), and that humans can contract Plague from Cats. The Plague bacterium (*Yersinia pestis*) that had its genetic code sequenced was in fact taken from the body of a vet in Colorado who died from Pneumonic Plague after a Cat sneezed on him as he rescued it from under a house. Cats can also communicate Plague to humans through scratches, bites and infected fleas. More recent and unexpected research has demonstrated that feline immunodeficiency virus—FIV—can be communicated to primates (Macaques exposed caught the disease) which then go on to develop the typical symptoms of AIDS already well-known and fatal to humans. Although there has as yet been no known transmission of FIV to Humans, the possibility is more likely now that it has been shown to be transmissible in particular to anthropoid primates, the group to which we belong. While these and other serious diseases that Cats and Dogs can communicate to humans are unlikely to stop people from having them as pets, they justify consideration of the potentially much *greater* safety of keeping native marsupials as companions. Many thousands of marsupials have already been kept as companions and few if any serious illnesses to humans have resulted—an expected result given the evolutionary distance of marsupials and placentals. Viggers and Lindenmayer (2002), while stressing the possibility that Australian native animals might have as yet undetected illnesses that we might be able to catch, fail to mention the many serious illnesses we are *known* to be able to catch from Cats and Dogs. While agreeing that lack of caution is never wise, we should not turn our back on trials of *native* animals as potentially much safer companions. To do so would really be an abuse of the precautionary principle. If worries about *imagined* diseases in marsupials are valid reasons for not taking the risk of trialing them as companions, where is the converse logic in continuing to promote Cats and Dogs as companions when they are *known* to communicate serious and sometimes fatal diseases to humans?

6. Successful programs overseas involving Australian animals as companions

There are already many programs in place for keeping Australian native animals—and they are successful. Besides the few programs already underway and successful in Australia, there is a

blossoming American trade in some Australian/New Guinean marsupials such as that in Sugar Gliders (*Petaurus breviceps*) which are marketed there as 'Pocket Pets' in reference to their small size and tractability. A spin on the internet reveals many overseas Sugar Glider Societies, support organisations and care manuals that maximise the likelihood of these captive-bred, beautiful and social marsupials making successful companions. The irony of having the United States declare and demonstrate the success of keeping Australian marsupials as companions will not be lost on those trying to promote—in our case as a conservation strategy—the same initiative within Australia.



Fig. 12. Some Australian native mammals have already been trialed overseas as well as in Australia and found to be excellent companions. Sugar Gliders (*Petaurus breviceps*) are among the most popular 'pocket pets' in the United States with support organisations, care manuals, breeding facilities and experienced vets in 20 States. (Courtesy International Sugar Gliders Association)

7. Conservation costs of sticking with 'business as usual' as the only way forward

One of the most important reasons for advocating native animals as companions is that 'pets as usual' is *not* contributing in any way to conservation of our native animals. Quite the contrary; if it remains unchanged, it will lead to further losses of native species and continuing degradation of the bush. This is not to say, of course, that land-clearing and

other factors damaging the bush are not major issues limiting the prospects for long-term conservation. But those factors do not nullify or make irrelevant conservation losses attributable to Cats and Dogs. These are constantly escaping or being released into the bush with predictable consequences—massive numbers of consumed native animals being turned into more feral Cats and Dogs and more risk of toxoplasmosis being communicated by Cats to marsupials in the bush. Some wildlife experts consider that, after drought, toxoplasmosis communicated by feral Cats is the second biggest killer of native animals. In a publication entitled *Cats and wildlife*, Anon. (1994) notes that Cats have been found to eat more than 186 species of native birds, 64 species of mammals, 87 species of reptiles and 10 species of frogs, and that the average feral cat probably kills at least 1,000 native animals a year. Dickman (1993) provides a sobering review of the ecological impact of feral Cats and Hopwood (2001) notes that domestic Cats consume between 30-63,000,000 native birds alone each year. Add to this the other issues noted above, including the fading focus the next generation appears to have on the welfare of our native species, and it seems to me more than enough reason to seriously examine the potential conservation benefits of keeping native animals as companions. Why is it that we can earn accolades, trophies and money for breeding and selling introduced Cats but be fined for breeding native animals? There seems an awesome lack of logic in this situation that we may well come to regret.



Fig. 13. There are those who see serious problems in having native animals as companions rather than or in addition to introduced cats and dogs; others see potentially vital conservation benefits in having this choice. (Courtesy M. David)

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Fig. 14. The common and widely promoted alternative to keeping native animals as companions leads to proliferation of introduced species known to transmit disease and cause significant environmental damage, such as Cats. (WEB image)

8. How could we begin to turn this around?

What form could the native animals as companions initiative take? Certainly we should not begin any trials before we have considered the issues noted in Viggers & Lindenmayer (2002) and by others whose experience in this field merits attention. However, the *possibility* of a potential problem should not in itself be an obstacle to conducting a trial under controlled conditions. It is possible to abuse the precautionary principle in this situation by using it to prohibit the trialling of potentially important conservation initiatives because all of their outcomes cannot be determined before the trial. That is the point of trialling these initiatives under controlled circumstances rather than simply giving them an immediate and free run.

If suitable native animals, identified through this process, are bred in disease-free colonies, they could be sold for a substantial price with part of the money going to traditional conservation projects focused on the welfare of the same and other species in the bush. Suitable species are not necessarily those known to be common or in no danger. In fact, as Paul Hopwood (2001) has

frequently pointed out, it is the species that are endangered that are most in need of urgent attention of this kind precisely because for these species 'conservation as usual' is failing. Examples would include the Western and Eastern Quolls (*Dasyurus geoffroii* and *D. viverrimus*) which have massively declined in geographic area since Europeans arrived, and Mitchell's Hopping-mouse (*Notomys mitchelli*) which while still surviving in southern South Australia and Western Australia, has become extinct in New South Wales.

Although other species should be considered in terms of their eligibility, many of us consider that we should trial one or two native animals first if for no other reason than to test through this process the principle that having native animals as companions can produce conservation benefits without increasing risk. In the process of planning these trials, all legitimate concerns raised in the paper by Viggers and Lindenmayer (2002) and others should and would be considered. But it is important to recognise that identifying issues of concern does not in itself provide a reason not to trial those initiatives through carefully-conceived and managed programs. That is the strategy those of us looking for increased conservation benefits through programs of this kind have always advocated.

Should programs of this kind be restricted to animals? Should we challenge the propriety of being able to buy threatened native plants produced in nurseries as 'companions' to plant in our back yards? This capacity is taken for granted as one among many compatible conservation strategies that minimise the likelihood of extinction of endangered plants. My backyard in Maroubra is planted with native species that were almost completely destroyed as developers gradually cleared the surrounding bush decades ago. The Randwick City Council, with Danny Ondinea, ran a program of gathering and germinating seeds from these native species and providing these to anyone willing to grow them instead of Oleanders, Hydrangeas, Camellias and other introduced garden plants. When the Wollemi Pine was discovered in its last-known refuge in the Blue Mountains, sense prevailed and the Royal Botanic Gardens of Sydney initiated propagation programs to enable interested members of the public to purchase this species thereby engendering commitment to its conservation and creating many more breeding populations of this otherwise severely endangered 'Pineosaur'. The principles and conservation goals in these initiatives for plants and animals are basically the same.



Fig. 15. The Wollemi Pine (*Wollemia nobilis*), recently discovered and one of the rarest plants in the world, is being cultivated in breeding facilities with the intention of eventually providing plants for sale as one measure to increase the chances of survival of this highly endangered species. (Courtesy Royal Botanic Gardens of Sydney)

Other controversial strategies to help avert conservation catastrophes

There are many other compatible strategies that could be critical for conservation, such as reintroductions and creation of genetic libraries that anticipate crises.

I. Reintroductions informed by understanding of pre-modern distributions

Before push comes to shove and *whole* species are at risk, I would urge we consider all available data about former habitats, some of which comes from the fossil record. For example, before rising global temperatures profoundly

alter the remaining alpine habitats of the Mountain Pygmy-possum (*Burramys parvus*), it would be wise to consider controlled, trial releases into the mammal-poor lowland rainforests north of the Daintree. Why? Because for the last 24 million years of burramyid possum evolution, species of *Burramys* have always been compatible members of lowland rainforest communities. Even as recently as 4 million years ago, they were in lowland rainforests in southwestern Victoria. What would we lose through a controlled trial except possibly reduction in risk of lineage extinction? This is a four-dimensional extension of the principle of seeking Indigenous knowledge about the

potential ranges for modern species known before European arrival. As many politicians and biologists and even the odd astronomer or two have commented, the further backward you look, the further forward you may be able to see.

2. Creation of genetic libraries—potential capacity for the future

The wisdom of this strategy has been accepted by most biologists concerned by current rates of extinction and the need to have the capacity at some time in the future to reconstitute genetic variants or even species when we and the world are well again. While most biologists would also question the probability of being able to recreate extinct species, few disagree with the need to secure resources that *might* allow this to happen.

The Australian Museum's Thylacine Project is driven by the opportunity, afforded by a Thylacine pup (*Thylacinus cynocephalus*) pickled in alcohol (a DNA preservative), to see if it is in fact possible to undo extinction. Considering that

their 'time' was not up and that we, not environmental change or evolution, hounded them into extinction, many think that if we have the capacity, we have a moral responsibility to do whatever we can to bring them back—to give them and us a second chance. There are other pickled pups in other institutions providing the potential for recreating both sexes and genetic variation. If one cloned Thylacine can be produced, thousands can. What would we do with them? If successful, we would seek to maximise their chances for survival and a new future through compatible conservation programs including captive breeding colonies, releases into sanctuaries, protected islands and assisted establishment into still-suitable traditional habitat in Tasmania. Perhaps we would also consider a compatible program in which surplus individuals were available for human companions, a strategy that if followed a century ago might well have made this whole Project unnecessary.



Fig. 16. If all else continues to fail, there is a remote possibility that extinct species could be resurrected from stored DNA. The Australian Museum's Thylacine Project is based on recovered DNA from a pickled pup (left). If the Project, against all odds, succeeds in producing many individuals, there are still many areas in Tasmania with entirely suitable habitat into which it would fit like a recently removed hand from a still-warm glove. (Courtesy Nature Focus)

The probability of success for this Project based on current technology is low; but the likelihood of a positive outcome without trying is infinitely less. And along the way we will be pushing forward the research frontiers of this extreme strategy for conservation. Given the enormous amount of effort required and uncertainty of success, it is clearly *not* an alternative to traditional conservation strategies—if anything, quite the reverse. But, because it is a potential compatible conservation strategy in ‘hopeless’ situations, we are going to push those frontiers as hard as we can to see what is possible. If we fail, there is not the slightest doubt that other more technologically-capable successors will begin again where we leave off. Already other labs, like Advanced Cell Technology in the United States, are doing things once thought impossible such as inserting the nuclear DNA of endangered species (such as the Mouflon Sheep, *Ovis musimon*) into the host cells of a different species and producing viable, healthy offspring that are clones of the endangered species. If this much has been done in the decade since the likelihood of cloning was regarded as an absurd impossibility, how can we say what will be impossible in the decade to come?

We are not the first to trial alternative conservation strategies

While not all of these alternative strategies are in use in other countries, some have been wholeheartedly embraced elsewhere (e.g., Kiss 1990, Nations 1992, Marks 1994, Hasler 1999, Falkena 2000, Damm in press). Compatible conservation programs for sustainable harvesting, hunting, farming, ecotourism and protected area strategies are being run successfully side by side in many African, North America and European countries. Their ongoing experiences, relevant to Australia, are the subject of a review in preparation, but comments (courtesy B. Bohdanowicz and G. Wilson) are appropriate here.

1. Demonstrable successes

Examples were presented in a recent conference in Pretoria which several of us from the Australian Museum attended. One example from Namibia involved privatisation of environmental management and anti-poaching functions that resulted in a 44% increase in native species, an increase of 88% in numbers of animals and biomass, and development of an economically significant blend of game-farming, game-hunting



Fig. 17. There is an awful irony in the possibility, given Human indifference to the need for effective long-term conservation strategies, that even if the Thylacine could be resurrected, there are still individuals who would be intent on pushing it over the brink a second time. (Courtesy Polly).

and tourism. East African examples (e.g., from Zimbabwe and Botswana) involved transfer of wildlife ownership to landowners which led to substantial improvement in the local economy and increased well-being of these communities. Local communities benefited by access to game meat for local consumption as well as income generated by limited trophy-hunting.

Demonstrably compatible models of wildlife management are working in southern Africa including private game ranches, cooperative game reserves (conservancies) and national parks and reserves. Considering private game ranches, there has been a rapid increase in the number of game farms and ranches with approximately 9000 in South Africa in 2000, covering 13% of the country's land area compared with 5% allocated to national parks—the result of exponential growth in game ranches which has occurred in the last decade. With demonstration of the viability of these new initiatives, more and more traditional cattle-ranching operations are moving over to game-ranching.

Many of these game ranches operate on narrow margins because their operations are small or they have little focus on ecotourism. Larger private game ranches, however, are very

lucrative. Current high prices paid for disease-free game (e.g. Buffalo currently bringing A\$45,000 each) have supported high capital investment in specialised secure facilities. Although market prices will probably decline with time, these breeding facilities are usually combined with other activities that make them more sustainable in the long term such as ecotourism and photographic safaris as well as meat-production and trophy-hunting, activities well-established in African culture.

Emphasis on cooperative land ownership (called conservancies) is a common feature of many of the African initiatives. These help to leverage benefits from large fence-free tracts of land dedicated to wildlife utilisation because they are able to accommodate the large home ranges required by free-ranging large species.

Many African examples of this model of cooperative properties pooling their resources in a “commons” model are known. As well as noting direct benefits to farmers and land-owners, several speakers at the Pretoria Conference described successful examples of cooperative arrangements that also provided benefits from wild game-harvesting to the surrounding and/or participating communities.



Fig. 18. Many antelope species such as eland are free ranging on large game ranches with some feed supplementation provided during extended dry periods. (B. Bohdanowicz)



Fig. 19. The number of privately owned game ranches in Southern Africa is increasing rapidly. Species such as elephant and buffalo are very lucrative both for game viewing and sale of live animals to other game reserves locally and internationally. (B. Bohdanowicz)

The CAMPFIRE Program in Zimbabwe (e.g., Hasler 1999, Child 1994, Martin 1994, Holdgate 1996), Community Management Programme For Indigenous Resources, initiated in 1988, has evolved from a fledgling concept of ‘community-based wildlife management’ to a mature ‘co-management’ that has achieved a balance between the previously competing interests of different groups—i.e., stake holders such as the state, community, private sector, international wildlife lobby groups, etceteras. Through these co-management strategies, CAMPFIRE has successfully returned responsibility for management of indigenous natural resources to rural communities. Before it was established, most of the large animals involved such as Elephants were considered by villagers with at best indifference but more commonly as pest species because they raided and trampled their gardens—in short, they were not valued on private land. Hence poaching had become so rife that wildlife managers were soon helpless to stop it and wildlife numbers were declining. The solution was to enable visiting hunters to pay for the opportunity to cull individuals as part of a managed program of sustainable, free-range harvesting. The money derived was shared with the local villagers and the National Parks system to provide effective conservation management, something they could not previously afford to do, and the meat so derived was provided to the villagers as an added benefit. By 1992-93, the villagers had begun to value the biota because it brought a sustainable income, poaching was in significant decline, the conservation capacity of private land involved had significantly increased and there was less dependence on and use of introduced cattle.

Martin (1994), who promotes the CAMPFIRE and other programs in Zimbabwe, points out another aspect of this conservation strategy that to some is counter-intuitive. Under traditional protectionist philosophies, rare species are the last to be considered appropriate for consumptive use. In reality, it may be that the rarer the species becomes under failing protectionist strategies, the more urgent is the need to explore new initiatives that focus on giving it value. He comments “we...have a policy whereby any species whose numbers have *not* increased as a result of legal protection are now being ‘deregulated’ and, under cautious monitoring, various uses are being permitted. This seems to be producing positive results (e.g., with cheetah and roan antelope) and it gives the lie to the Precautionary Principle in the given circumstances.”

Trophy-hunting of Elephants and other large animals in these programs is a key contributor to their success so it would be fair to wonder about public attitudes to the consumptive use, sustainable or otherwise, of iconic wildlife. There appears, however, to be little if any problem with multiple use programs that include sustainable harvesting in Zimbabwe. This is particularly true because these programs demonstrably provide conservation benefits in ensuring long-term survival of species that are the focus of the Program and incidental benefits for thousands more because their natural habitat is increasingly valued. In the same way, the fact that the Giant Sable is the national symbol of Angola does not inhibit its sustainable use by that country as a valuable source of meat and income through hunting as well as tourism and other compatible activities. Multiple use programs of a similar kind focus on American Elk and Deer. While all Americans love the Disney film ‘Bambi’, millions do not hesitate to hunt and eat venison. Clearly, it is possible to have one’s national icons and eat them too. In fact, in some situations it may well be a practical prerequisite for their long-term survival.

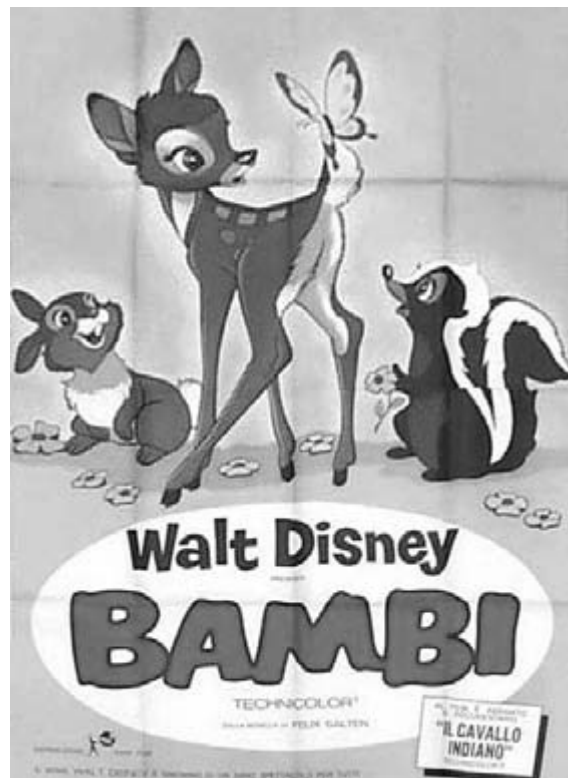


Fig. 20. There are few problems in other countries with sustainably harvesting species that are also national icons. While American children love Bambi, as adults they also value venison (WEB image).

Child (1994) concludes from his experiences with the CAMPFIRE Project and others like it that the keys to their success have been to: “make wildlife so valuable that farmers conserve it; recognize that resources compete for space and that in certain situations wildlife is the most productive and sustainable form of land use; recognize that economic signals will decide the survival of wildlife outside protected areas, and therefore make sure that these signals reflect the true value of wildlife; promote the value of wildlife in a situation where landholders and communities are resource proprietors; recognize that people who live with wildlife ultimately decide its fate; and recognize that they will only manage it sustainably when there is an economic motivation to do so, and when they have secure rights to manage and reap the full rewards of their management inputs, and to prevent others from doing so”.

2. Pitfalls to avoid

This is not to say that all sustainable-harvesting experiments have had nothing but positive outcomes. Along with its many successes, the southern African wildlife ranching model has revealed a few potential risks. The first arises from having too many *small* game ranches that, because of their small size, are unable to diversify investment risk and are under-capitalised for long-term survival in the face of economic challenges from other industries. Falkena (2000) suggests that some game ranches have been established because of a “...desire to improve knowledge of life by managing a relatively small piece of nature in an ecologically sustainable way”. Ideally, wildlife ranches should be large enough or sufficiently amalgamated to achieve long-term economic resilience.

The second risk is diminished gene pools in the absence of a coordinated program to mix genetic material between appropriate geographical regions. Reserves that are too small could inhibit evolutionary resilience by restricting genetic variation in natural populations. Although it is not clear how important this is for all species because some, such as Cheetahs, are able to persist with considerably less variation than others, larger populations on average will be more resilient to challenges than small ones. Most of these problems could be overcome through the strategy of developing ‘commons’ which would create greater effective areas, population sizes and economic resilience.

Hopefully future research in Africa will test the equally important hypothesis that valuing strategies of this kind will benefit the other 99% of the biota because of the community’s need to preserve natural habitat that produces the sustainably harvestable species. Most of the African trials underway have been driven in the first instance by the need for more effective conservation of the more visible and hence more valuable species such as mammals and birds.

Consequent biodiversity benefits are complex and often controversial outcomes to demonstrate let alone quantify (e.g., Faith 2001). But without a long-term assessment process in place, it will be impossible to test the hypothesis that biodiversity overall would benefit from sustainable use of native resources.

Another feature of the African models as a whole is that many have developed in an *ad hoc* manner, integrating a dynamic blend of scientific as well as non-scientific approaches, traditional and innovative strategies. The outcomes, successful or otherwise, of many of these initiatives could be described as the result of ‘learning on the job’. Serendipitously, those of us now conceiving Australian programs to increase conservation/cultural benefits have the advantage of examining the outcomes of different kinds of trials already underway in Africa.

FATE: putting hypotheses about the win/wins of valuing to the test

All would be rhetoric if rhetoric were where this proselytizing stopped. For years I have been lecturing to anyone who would listen that we must get off our rear ends, now, and do something to turn things around. The losses, the problems, the compromised futures for rural and regional Australia as well as our biota, are all painfully clear. As those concerned about lack of government commitment to reducing greenhouse gas production point out, when your house is burning, you don’t turn your back on the crisis to demand more research into the causes of fire—you put the fire out to minimise the loss and *then* do the research to reduce further risk. As Paul Ehrlich has said, the first rule of intelligent investigation is to keep all the parts. That is not to say that long-term research into the causes for ecological/extinction crises is in any way not an absolutely essential focus; quite the contrary—it is the critical core of the strategy outlined below to test the hypothesised gains in

biodiversity and economic viability for rural and regional Australia. That said, the undisputed need for more research into conservation/extinction issues should not be used as an excuse for not tackling accepted threats to biodiversity such as land and water degradation.

1. Accepting the need for change

At the most basic level, transcendent factors that have been damaging our rural environments and lifestyles have been identified, such as land-clearing, uncontrolled irrigation and overuse of inappropriate fertilisers. Thousands of research papers and books have already been published about the topic. Eurasian-style agriculture using monocultures of introduced species to feed an increasingly overpopulated continent has taken us down a steep and degrading path. We know this and we have done a lot of talking about what we should do to turn things around, but adequate incentive to change, apart from fear, always seems to be not quite there. We are creatures of habit who find it very difficult to change old habits, particularly when those were the result of programs once advocated in good faith by government. Having been urged for so long *not* to integrate ourselves sustainably into the natural resource systems of Australia, we now find ourselves in deep trouble on both sides of the fence. Yet it is my personal conviction that we can change, and can achieve a sustainable life style, if we do it gradually, and if there is real economic incentive for taking each step along the way.

2. The FATE Program—proposal for experimental trials in the degrading rangelands

FATE stands for the Future of Australia's Threatened Ecosystems. Although an initiative of the Australian Museum established in 1999, the FATE Program is now a whole of Government initiative with many agencies and non-government organisations involved to one degree or another as partners. The FATE Team within the Australian Museum has coordinated two workshops to define and refine the objectives and strategies of the Project. In its simplest concept, the FATE Program is to be a test of the hypothesis that long-term benefits for biodiversity and rural and regional Australia can be achieved through sustainable use of native resources. It will build on what has been discussed above, and the wisdom of many Australians who for years have articulated the same vision in one form or another. We have got to change our mindset about appropriate ways

to use Australia, its lands, its waters and its life, or the future will be bleak.

As I write, we are nose-down and bum-up refining the final form of the FATE Program Proposal. Although it will be a dynamic and wide-ranging program of initiatives, both conceptually and geographically, it will have as its first focus the degrading rangelands of New South Wales which are suffering some of Australia's highest losses in biodiversity and lifestyle of its peoples. We have yet to pick the most appropriate precise location(s) but have been traveling throughout the State, talking with graziers and local communities who have an interest, often as keen as ours because of increasing desperation as well as shared vision, to take part in the FATE Program.

Although details of the proposal will change as the Program develops, we intend to select a bioregion or basin within which many graziers would be keen to work with FATE advisory groups to develop wildlife conservancies that operate as a 'commons' (e.g., Brunckhorst 2000, Coop & Brunckhorst 1999). These commons, as currently conceived, would involve cooperative adjacent properties and a sharing of profits from sustainable harvests on an equity basis reflecting the share of resources each property brings to the consortium. Properties that did not wish to participate would act as experimental controls. Within this bioregion, various initiatives would be explored depending on the attributes of the particular situation but in each case the goal would be to diversify their resource base for greater economic as well as environmental resilience.

Despite differences, the private game ranching industry in southern Africa offers useful insights. The African "wild game ranching model" is based on large mammal species that are able to deliver huge economic returns in terms of meat production, breeding stock value and ecotourism. Although Australia does not have as many large species with the same tourist appeal, the ability to develop a successful *multiple* landuse model based on the utilisation of large kangaroo species for meat production together with cultivation of suitable native plants for commercial products such as food, timber and pharmaceuticals (i.e., consumptive use) and an ecotourism/farm-stay experience that showcases Australia's unique (albeit smaller-sized) fauna and flora as well as Australia's stunning landscapes (i.e., non-consumptive use), presents very significant potential for regional conservation and economic benefits.



Fig. 21. In the rangelands of western New South Wales, graziers who appreciate the value of kangaroos often have large mobs on their properties as well as sheep and cattle. Sustainable harvesting of these populations should have conservation and economic benefits in all directions (M.Archer).

While the long-term goal would be to maximise both conservation and economic benefits through a progressive shift to dependence on sustainable harvesting of native resources, this would inevitably be a gradual process dependent on the demonstration that there *were* economic and conservation benefits in the new strategies. The trial might begin with a dedication of 10% of a grazier's property, ideally adjacent to similar areas dedicated to the same purpose by other members of the consortium, to establish or protect a conservancy of natural bush from which native resources would be sustainably harvested for profit (Davis 1995 reviews similar functional models). On the rest of the property, it would be business as usual. Then, if the sustainable harvesting is yielding the anticipated value-adding benefits, this would be encouragement to consider increasing the percentage of the property dedicated to this 'natural' purpose, further pulling back from dependence on the monocultures of introduced species on the rest of the property.

Together, the particular blend of initiatives should value-add to rural/regional incomes, broaden the economic resilience of those properties and increase economic dependence on healthy natural environments. Ultimately, it should reduce infrastructure needs for individual graziers through sharing of harvesting costs, even reducing the need for fences as more free-ranging or dispersed native resources are shared between properties. The land would begin to heal as a brighter, more resilient future took shape.

We also expect that this Program would have an adaptive land-management strategy component such that activities conducted on particular properties or parts of properties might well change as individual FATE trials progressed, although the need for long-term scientific monitoring of effects arising from particular strategies would also need to be met to maintain our ability to test the basic FATE hypothesis about anticipated biodiversity/conservation gains.

We also visualise that isolated properties, in other regions, would become showplaces for particular FATE strategies such as the sustainable harvesting of a species of native berry or timber, and a Friends of FATE community-based organisation that could provide a framework for urban individuals as well as core participants to actually become involved in progressing these conservation initiatives in rural and regional areas.

Marketing concerns are vital and various strategies are now under discussion including ways to market-advantage *all* products (including sheep and cattle) produced on cooperating properties because they are participating in the FATE conservation initiative. At the same time we are planning native food festivals in capital cities to introduce Australians outside of rural and regional Australia to the wonderful tastes and other values of native resources, a strategy aimed at encouraging new markets and incentives to invest in new conservation-advantaging products unique to Australia. We

are very clear in our own minds that marketing aspects of these initiatives are vital if the whole strategy is to be successful. There are some among us who even advocate that market issues should be the primary ones addressed to ensure the success of the rest of the Program.

The conservation benefits we expect cannot be taken for granted. Devising and carrying out scientific tests to see if these actually do occur will be the primary responsibility of the Australian Museum and Royal Botanic Gardens of Sydney. The scientific model that will be a core part of the FATE Program is now being finalised. One aspect will be initial bench-marking of biodiversity levels followed by long-term monitoring of changes in the amount and nature of biodiversity taking place on control properties as well as participating properties that are changing aspects of their land-management strategies. A key element of this assessment is that it must be regional in focus. We hope to find biodiversity gains from sustainable harvesting land uses that are complementary to biodiversity protection elsewhere in the region. In this way, sustainable harvesting land use can feed into 'regional allocations of dedicated conservation, mixed use, and development that together maximise net benefits for society' (Faith 2001).

3. In principle support and objection to sustainable harvesting of native resources

The concept of the FATE Program has support from many directions. Besides the millennia of life-dependent testing it has had from indigenous peoples on most continents and the current range of initiatives working on other continents, it also has legislative backing at all levels. Internationally, IUCN Resolution 18.24 agreed to at the World Conservation Union Meeting in Perth in 1990 and Resolution 2.16 agreed to by the WCUM in Jordon in 2000 both stress the global importance of sustainable harvesting native resources as a conservation initiative. In Australia, there is the Environment Protection and Biodiversity Conservation Amendment (Wildlife Protection) Bill 2001 and the 1998 Senate Inquiry into Commercial Utilisation of Australian Native Wildlife. In New South Wales there is the Sustainable Agriculture legislation policy document. This policy was launched in December 1998 by the Minister, Richard Amery. A review group was formed in April 1999 charged with responsibility to report to the Premier and Minister for Agriculture on its implementation.

Many professional non-government organisations have taken similar stands about sustainable harvesting when it can be shown to be sustainable. The World Wide Fund for Nature long ago committed its support for the biological rationale of sustainably harvesting kangaroos. Similar support now comes from the Ecological Society of Australia (ESA) and the Australian Mammal Society (AMS). The AMS Position Statement on *The commercial harvesting of macropods*, adopted at its AGM in July, 2001, recognises: "That a reduction in total grazing pressure could be achieved more easily if the value of kangaroo products rose to the point where they could be seen by landholders as a valuable resource; and the potential role of an increased-value kangaroo industry to help achieve that reduction, through providing landholders with a mechanism to maintain economic viability at reduced sheep numbers; and therefore SUPPORTS IN PRINCIPLE the idea of achieving a conservation benefit from a government regulated, high value, sustainable kangaroo industry." The ESA "Supports the concept of sustainable wildlife use. Harvest of native wildlife provides an alternative to traditional agricultural practices that would allow natural habitats to provide an income to landowners, and hence a reason to conserve native wildlife and their habitats. Sanction of a harvest or other use should take into account potential benefits to the conservation of the species and their habitats". The Australian Veterinary Association's policy states that "The AVA supports harvesting and culling of native fauna provided it is done in a humane way in accordance with current scientific knowledge and agreed management plans and so as not to affect threatened or endangered species". In its submission to the 1998 Senate Inquiry into Wildlife Utilisation it stated: "The Australian Veterinary Association believes that the Australian kangaroo population is a unique and valuable resource and that harvesting is a legitimate and humane use of that resource" (AVA 1998). Similarly, the Australasian Wildlife Management Society's Position Statement on the Sustainable Commercial Use of Wildlife (1999) "SUPPORTS the concept of achieving habitat and species conservation goals through the sustainable use of wildlife, whether consumptive or non-consumptive, as spelled out in the resolution adopted at the December 1999 General Assembly of the International Union for the Conservation of Nature (IUCN)...". Similar

support comes from CSIRO and the Australian Association of Veterinary Conservation Biologists. These views and those of many other international and national bodies clearly lend support to the importance of trialing initiatives that could test the potential conservation benefits of sustainably harvesting native wildlife.

Some organisations, on the other hand, are opposed to sustainable harvesting initiatives, such as 'Australians Against the Commercialisation of Wildlife', 'Animals Australia' and 'Viva!', the latter being an organisation that opposes the eating of *all* meat ('Vegetarians International Voice for Animals') although its recent campaign in Australia, focused as it was solely on the harvesting of kangaroos rather than the eating of all meat, failed to draw attention to its overall objectives. In reality, Viva! would rather Australians chucked a lettuce on the barbeque. Other organisations have mixed views in their membership and therefore not surprisingly may have mixed views in their policies. For example, the Australian Conservation Foundation's original position (expressed in ACF Viewpoint No. 1) was: "The Foundation can see no moral argument against the economic utilisation of native animals, provided it is carried out under strict control and is based on biologically sound management procedures." Lunney (1995) suggests that their current anti-kangaroo-harvesting position "...appears to owe more to one faction of the animal welfare lobby than the concept of conservation...". Because there is significant division today within the ACF's ranks about this conservation initiative, it is possible that its views in this area might be reconsidered again at a later date, particularly if demonstrations of the conservation value of sustainable harvesting programs continue to unfold. On three recent occasions, appeals by animal rights organisations for demonstrations to protest some of the concepts discussed above resulted in very small turn-outs (rarely more than a familiar group of 20). While I respect and welcome contradictory views, theirs would appear to represent a small minority of the population with far more people keen to trial new initiatives that would increase conservation of the biota and rural and regional Australia.

Comparing the merits of the key industries that utilise our land

As a beginning student who knew very little about the relative merits of processes that threatened environments, I just accepted the given wisdom that somehow highest on the list of

evils was mining. In the 1960s, few of my colleagues in universities and museums mentioned or even noticed problems caused by agriculture, but if a new mine were proposed, vitriol and indignation were quick to follow. Queenstown, Tasmania, was often cited as an unimaginably horrific demonstration of the environmental disasters of mining.

Somewhere along the line, I opened my eyes. The first time the blinkers came off I was flying over eastern New South Wales staring out at the vast patchwork quilts of dry fields, erosion gullies and nearly treeless planes that stretched from horizon to horizon—the big wide brown. The few, isolated native trees left, living dead reminders of what was formerly there before the forests were clear-felled, ring-barked, burned or had their seedlings incessantly eaten by sheep or cows or destroyed by newly-risen salt, came suddenly into focus. The problem is not mining which takes up a minuscule 0.02% of the Australian surface (1,520 km²); it is traditional agriculture which has been degrading 70% of the continent (5,320,000 km²) (Archer 1995).

Once the blinkers came off, nothing seemed the same to me again. The Government's *Ecologically sustainable development working groups; final report on Agriculture* (Anon. 1991) as well as *Mining and Tourism*, provided a warts and all costs and benefits analysis of these and other major industries. Agriculture came out poorly with high costs and relatively low net yields, while mining was producing relatively large benefits for negligible cost. Currently, mining produces \$35 billion in exports which represents 34% of Australia's merchandise and over 6% of Australia's Gross Domestic Product (GDP). On balance, mining is three times as financially rewarding and 3,500 times less ecologically destructive than agriculture. An increasingly long string of overviews, including Beale & Fray (1990), Flannery (1994), Francis (1998), Lowe (1999), White (1997), Pratley & Robertson (1998), Horton (2000), Rolls (2000) and many others, end with the same bony finger left pointing at traditional agriculture as the land use strategy most in need of help.

The FATE Program has been conceived in the hope that it will help to change our views about the best way to sustainably utilise the land. But a national refocus is also needed to reassess the relative merits of the three biggest industries that utilise the land: agriculture, mining and tourism. A rebalance of benefits and land damage should

see far more encouragement given to the mining sector and tourism and far less to traditional forms of agriculture. The latter, not the former, mines Australia unsustainably.

And yet, if agriculture can be economically encouraged to embrace sustainable harvesting of native wildlife, it will of necessity conserve rather than consume the environment and in the process increase its own long-term future. Where once it was the proud and unassailable king of Australian industries, so it could be again.

Battling over the high ground of the heart

At the Royal Zoological Society of NSW's forum *A Zoological Revolution*, several of us advocating the potential conservation value of sustainably using native resources found ourselves accused of 'not loving' animals for their intrinsic value rather than for their potential economic value. Gordon Grigg spoke for us all when he expressed his outrage at this remark. All zoologists I know who committed their lives to this field of research did so precisely because they do love animals, sometimes more than they can express. In my own case, I was carved from a warm, fascinating and very private childhood spent in the wetlands behind our house, summer and winter, interacting with turtles, frogs and snakes, and hugging trees as hard as my little arms could squeeze.

I suspect childhoods of this kind were common to many kids who later grew up to become biologists. To suggest that we who started out this way somehow love animals less because our research now involves scientific rigour and rational thought betrays a fundamental failure of understanding. What I am suggesting in this paper is advocated not for some avaricious, heartless or academically sterile reason but precisely because I *do* love animals—and because I flatly refuse to allow 'conservation as usual' to enable these creatures to disappear without first having tried everything that could work to turn this awful tide of loss around.

Damm (2000), considering appropriate strategies to save Africa's wildlife, commented that "Those who would bring an end to the sustainable use of nature claim to possess a special sensitivity towards animals. But they eat meat from slaughterhouses, where others are paid to do the killing on their behalf, they wear leather shoes and enjoy vegetables, fruit and grain grown on lands taken away from wildlife". My frustration,

and that of others who share my vision, is with some conservationists and animal rights advocates who close their minds to potentially effective ways to deal with the ugly reality we have created—the world's sixth great extinction event, one that now threatens our own survival should we fail to understand what must be done. To advocate that we will stop the extinctions by isolating wildernesses and not interfering with the biota is almost certainly to doom that biota—if that is all we do. Wilderness is a nonsense, a phantasm that arose after we walked out of Eden. With the possible exception (an ephemeral one at best) of the polar ice caps and a few islands, humans and the world's biota have been integrated for hundreds of thousands of years. If the natural world is to have a future, we need to understand that love of animals has always led to a commitment to conserve when it was built on use and dependence—not independence.

Indigenous peoples who remain hunter/gatherers have a love and respect for animals, plants and ecosystems that most of us simply could not understand, because in contrast to us they are still an integral part of the environments upon which they depend. Their attitudes are shaped by thousands of years of understanding about the need to integrate with and care for that which they depend on. Once we stepped over the fence we built and walked out of that world, we lost the plot and stole their future. The mindset of animal rights advocates who argue against the value of using animals would seem as absurd and incomprehensible to hunter/gatherers as it would be to the animals themselves. To argue, for example, as animal rights advocates have with me, that a Koala would rather be dead than sold to become an exhibit in a Japanese zoo, strikes me as extraordinarily presumptuous, particularly on behalf of the Koala who I suspect would be as willing to pluck gum leaves in Tokyo as Taronga if given that same choice.

The initiatives I advocate that we should trial are built on respect for strategies that have worked for thousands of years, driven by love of the creatures I want to see conserved for the future and rationalised by expectation that increasing their value to rural and regional Australia will help to ensure their future and that of the biotas of which they are a part. What we need now are not arguments about conservation driven solely by the heart *or* solely by the head; we need an agenda built on the combined wisdom of both *or* both are going to fail.

Conclusion

Among the first jokes I heard in the bush in the 1960s was the one about the parrot and the stone: when cooking a parrot, toss in a stone; when the stone is soft, throw away the parrot and eat the stone. I did not hear this joke until after I'd had a meal of cooked parrot provided by a bushy living on the edge of what is now the salt-scalded wheatfields of Western Australia. He had a permit to cull a limited number because they were raiding his orchard. It was so tasty that when I later heard the joke, I didn't understand it even though everyone else thought it was funny. My guess is that it would have been as meaningless to the early colonists and Indigenous Australians as it was to me. Native resources highly valued by Indigenous Australians for thousands of years and early colonists for decades, gradually fell out of favour as introduced European species, proper food for gentlemen, became more abundant at the expense of the devalued native species. So today the joke is funny to almost everyone because almost no one has eaten a parrot.

As clearly articulated in the Global Biodiversity Strategy paper in 1992, "Today's biodiversity conservation entails a paradigm shift from a historically defensive position - the protection of nature from the impacts of development - to an offensive effort seeking to meet people's needs from natural resources while ensuring the long term sustainability of Earth's biotic wealth."

There is little doubt in most people's minds that unsustainable land, environmental and cultural degradation provide an urgent imperative to change the way we now utilise Australian land. It is my view, shared by many others, rationalised by international and national legislation, encouraged by the success of similar programs on other continents, and enshrined in the developing plans for the FATE Program, that we have a moral obligation to rediscover how to tear down the fences and put people and environments back together for the benefit of both.

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Fig. 22. Sustainable use of native species has a very long, and in terms of conservation, very successful track record for securing species that we now threaten. (From the Thomas Dick collection).

It has often been said that museums need to be safe places for 'dangerous ideas', a stimulus for rational, open debate about important issues. Some would argue that the ideas presented above are of this kind. Yet I would argue that the only dangerous idea here is that we would *not* trial initiatives that could return a future to our environments as well as rural and regional Australia. But do we have sufficient courage to confront conservative views to trial these initiatives, or will we stick with 'business as usual' until there is nothing left to argue about? It is our call and the clock is ticking.

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References

- Allen, L., Hynes, R., Thompson, J., 1995.** Is commercial harvesting compatible with effective control of pest animals and is this use sustainable? Pp. 259-266 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Anon., 1994.** Cats and wildlife. Pamphlet of the Queensland Department of Environment and Heritage.
- Anon., 1996.** *Australia: state of the environment: an independent report presented to the Commonwealth Minister for the Environment by the State of the Environment Advisory Council / Australia.* Department of the Environment, Sport and Territories. CSIRO, Canberra.
- Anon., 1997a.** *Sustainable economic use of native Australian birds and reptiles: can controlled trade improve conservation of species?* Summary of a report of the same name for the Rural Industries Research and Development Corporation by ACIL Economics Pty Ltd in Conjunction with Agriculture Western Australia. RIRDC Research Paper Series No. 97/26.
- Anon., 1997b.** Exploiting our native fauna - culling, harvesting, farming? *Australian Biologist* 10: 23-30.
- Anon., 1998a.** *A full repairing lease: inquiry into ecologically sustainable land management.* Report No. 60. Industry Commission, Canberra.
- Anon., 1998b.** *Policy for sustainable agriculture in New South Wales / NSW Government, NSW Agriculture.* State Government of New South Wales, Sydney.
- Anon., 1991.** Ecological sustainable development working groups; final report—Agriculture. Australian Government Publishing Service, Canberra.
- Anon., 2000a.** *IUCN Policy Statement on Sustainable Use of Wild Living Resources.* Adopted IUCN's 2nd session by the World Conservation Congress, Amman, Jordan.
- Anon., 2000b.** *Summary statistics from the Collaborative Australian Protected Areas Database* ed M.A. Hardy. Environment Australia, Canberra.
- Archer, M., 1974.** Some aspects of reproductive behaviour and the male erectile organs of *Dasyurus geoffroii* and *D. hallucatus* (Dasyuridae: Marsupialia). *Memoirs of the Queensland Museum* 17: 63-67.
- Archer, M., 1995.** Pin pricks & verdant vistas. *Australian Natural History Autumn*: 80.
- Archer, M., Clayton, G. (eds), 1984.** *Vertebrate zoogeography and evolution in Australasia.* Hesperian Press, Perth.
- Archer, M., Arena, R., Bassarova, M., Black, K., Brammall, J., Cooke, B. N., Crosby, K., Godthelp, H., Gott, M., Hand, S. J., Kear, B., Krikmann, A., Mackness, B., Muirhead, J., Musser, A., Myers, T. J., Pledge, N., Wang, Y., Wroe, S. 1999.** The evolutionary history and diversity of Australia's mammals. *Australian Mammalogy* 21: 1-45.
- Archer, M., Burnley, I., Dodson, J., Harding, R., Head, L., & Murphy, A., 1998.** From Plesiosaurs to People: 100 Million years of Australian Environmental History. *State of the Environment Australia. Technical Paper Series.* Environment Australia, Canberra.
- Archer, M., Hand, S.J., Godthelp, H., 1992.** Back to the future: the contribution of palaeontology to the conservation of Australian forest faunas. Pp. 67-80 in 'Conservation of Australia's forest fauna' ed. D. Lunney. Royal Zoological Society of New South Wales, Sydney.
- Archer, M., Hand, S.J., Godthelp, H., 1994a.** Patterns in the history of Australia's mammals and inferences about palaeohabitats. Pp. 80-103 in 'History of the Australian vegetation' ed. R. Hill. Cambridge University Press: Cambridge.
- Archer, M., Hand, S.J., Godthelp, H., 1994b.** *Riversleigh: the story of animals in ancient rainforests of inland Australia.* 2nd Edition. Reed Books, Sydney.

- Archer, M., Hand, S.J., Godthelp, H., 1995.** Tertiary environmental and biotic change in Australia. Pp. 77-90 in 'a Paleoclimate and evolution, with emphasis on human origins' ed. E. Vrba, G.H. Denton, T.C. Partridge, L.H. Burckle. Yale University Press, New Haven.
- Archer, M., Hand, S.J., Godthelp, H., 1997.** Unrolling the prehistoric scrolls of prophecy—roos and rocks rule. *Landcare Australia Yearbook* 1997, 12-15.
- Archer, M., Hand, S.J., Godthelp, H., 1999.** The power of palaeontology, a new tool for conservation. Pp. 233-244 in 'Australia's lost world: prehistoric animals of Riversleigh'. Indiana University Press, Bloomington.
- Armstrong, J.A., Abbott, I., 1995.** Sustainable conservation—a practical approach to conserving biodiversity in Western Australia. Pp. 21-28 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Asafu-Adjaye, J., 1995.** Recreational hunting and wildlife conservation. Pp. 288-295 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Bailey, C., 2001.** *Tiger tales: stories of the Tasmanian Tiger*. HarperCollins, Sydney.
- Basile, A., 2001.** Hard truths about dogs, cats...hamsters and mice. *The Veterinarian* October 2001: 16.
- Beale, B., Fray, P., 1990.** *The vanishing continent: Australia's degraded environment*. Hodder & Stoughton, Sydney.
- Beale, R., 1999.** Wanted urgently: rational parks. *The Bulletin* April 27: 53-56.
- Beattie, A., Ehrlich, P.R., 2001.** *Wild solutions: how biodiversity is money in the bank*. Melbourne University Press: Melbourne.
- Bindon, P., 1996.** *Useful bush plants*. Western Australian Museum, Perth.
- Bomford, M., Caughley, J. (eds), 1996.** Sustainable Use of Wildlife by Aboriginal Peoples and Torres Strait Islanders. Bureau of Resource Sciences, Australian Government Printing Services: Canberra.
- Braithwaite, R.W., Muller, W.J., 1997.** Rainfall, groundwater and refuges: predicting extinctions of Australian tropical mammal species. *Australian Journal of Ecology* 22: 57-67.
- Brechin, S.R., Wilshusen, P.R., Fortwangler, C.L., West, P.C., 2001.** Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as social and political process. *Society and Natural Resources* (in press; <pwilshus@umich.edu>).
- Brody, H., 2001.** *The other side of Eden: hunter-gatherers, farmers and the shaping of the world*. Faber and Faber: London.
- Brunckhorst, D., 2000.** *Bioregional planning: resource management beyond the new millennium*. Harwood Academic Publishers, Sydney.
- Brunckhorst, D., Bridgewater, P., Parker, P., 1997.** The UNESCO Biosphere Reserve program comes of age: learning by doing, landscape models for sustainable conservation and resource use. Pp. 176-182 in 'Conservation outside reserves' ed. P. Hale, D. Lamb. University of Queensland Press, Brisbane.
- Bruneteau, J.P., 1996.** *Tukka: real Australian food*. Angus & Robertson, Sydney.
- Cadwallader, P.L., Lawrence, B.W., 1994.** Rehabilitation of native fish stocks in the Murray-Darling River System. Pp. 81-84 in 'Reintroduction biology of Australian and New Zealand Fauna' ed. M. Serena. Surrey Beatty & Sons, Chipping Norton.
- Cherikoff, V., Isaacs, J., 1991.** *The bush food handbook: how to gather, grow, process and cook Australian wild foods*. Ti Tree Press, Balmain.
- Child, B., 1994.** Using Zimbabwe's CAMPFIRE Programme to assess the value of IUCN's proposed Guidelines for the Ecological Sustainability of Nonconsumptive and Consumptive Uses of Wild Species. *Paper delivered to Workshop 3 at the 19th Session of the IUCN General Assembly, Buenos Aires, Argentina*.
- Choquenot, D., Caughley, J., McLeod, S., 1998.** Scientific, economic and social issues of the commercial use of wild animals in Australia. Pp 73-77. Bureau of Resource Sciences, Canberra.
- Choquenot, D., O'Brien, P., Hone, J., 1995.** Commercial use of pests: can it contribute to conservation objectives? Pp. 251-258 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Coop, P., Brunckhorst, D., 1999.** Triumph of the Commons: age-old participatory practices provide lessons for institutional reform in the rural sector. *Australian Journal of Environmental Management* 6: 69-77.
- Cribb, A.B., Cribb, J.W., 1981.** *Wild medicine in Australia*. Fontana, Sydney.

- Croft, D.B., 1999.** When big is beautiful: some consequences of bias in kangaroo culling. Pp. 70-73 in 'The kangaroo betrayed: world's largest wildlife slaughter' ed. M. Wilson. Hill of Content Publishing Co., Melbourne.
- Croft, D.B., 2000.** Sustainable use of wildlife in western New South Wales: possibilities and problems. *Rangeland Journal* **22**: 88-104.
- Damm, G., in press.** *Saving Africa's wildlife: a guide to the African renaissance in nature conservation.*
- Davis, R.K., 1995.** Using markets to achieve wildlife conservation. Pp. 92-98 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Delcourt, P.A., Delcourt, H.R., 1998.** Paleoecological insights on conservation of biodiversity: a focus on species, ecosystems, and landscapes. *Ecological Applications* **8**: 921-934.
- Diamond, J., 1999.** *Guns, germs and steel: the fates of human societies.* W.W. Norton, New York.
- Damm, G., in press. *Saving Africa's wildlife: a guide to the African renaissance in nature conservation.* Safari Club International, African Chapter, Rivonia (muskwa@ibi.co.za).
- Diaz, S., Cabido, M., 2001.** Vive la difference: plant functional diversity matters to ecosystem processes. *Trends in Ecology and Evolution* **16**: 646-655.
- Dickman, C., 1993.** Raiders of the last ark. *Australian Natural History* **24**: 44-52.
- Diekman, B. (ed.), 1995.** *Sustainable use of wildlife: utopian dream or unrealistic nightmare?* Proceedings of a Seminar on the Commercial Exploitation of Wildlife held at the Royal North Shore Hospital, St Leonards, Sydney, 23-24 September, by the Nature Conservation Council of NSW Inc.
- Ecological Society of Australia (ESA), 2001.** Draft position statement on the sustainable commercial use of wildlife. (www.massey.ac.nz/~bjmoyle/ESAWLUSE.htm)
- Ehrlich, P.R., Ehrlich, A.H., 1996.** *Betrayal of science and reason: how anti-environmental rhetoric threatens our future.* Island Press, Washington.
- Ehrlich, P.R., Ehrlich, A.H., Daily, G.C., 1995.** *The stork and the plow: the equity answer to the human dilemma.* G.P. Putnam's Sons, New York.
- Environment Australia, Department of the Environment and Heritage Collaborative Australian Protected Areas Database (CAPAD).** 2000-Home Page <<http://www.ea.gov.au/parks/nrs/protarea/pa99/intro.html>>
- Faith, D.P., 2001.** Overlap of species-richness and development-opportunity does not imply conflict. *Science* [online] (www.sciencemag.org/cgi/eletters/293/5535/1591).
- Falkena, H., 2000.** *Bulls, bears and lions: game ranch profitability in southern Africa.* South African Financial Sector Forum, Rovonia, South Africa.
- Field, J., Dodson, J., 1999.** Late Pleistocene megafauna and archaeology from Cuddie Springs, southeastern Australia. *Proceedings of the Prehistoric Society* **65**: 275-301.
- Flannery, T.F., 1990.** Pleistocene faunal loss: implications of the aftershock for Australia's past and future. *Archaeology in Oceania* **25**: 45-67.
- Flannery, T.F., 1994.** *The future eaters: an ecological history of the Australasian lands and people.* Reed Books, Sydney.
- Francis, J., 1998.** Australia: an environmental Riviera? *Australian Farm Journal January*: 67-68.
- Graham, C., Hard, D., 1997.** *Prospects for the Australian native bushfood industry.* Rural Industries Research & Development Corporation, Canberra.
- Graham, R.W., Lundelius Jr, E.L., Graham, M.A., Schroeder, E.K., Toomey III, R.S., Anderson, E., Barnosky, A.D., Burns, J.A., Churcher, C.S., Grayson, D.K., Guthrie, R.D., Harington, C.R., Jefferson, G.T., Martin, L.D., McDonald, H.G., Morland, R.E., Semken Jr, H.A., Webb, S.D., Werdelin, L., Wilson, M.C., 1996.** Spatial response of mammals to late Quaternary environmental fluctuations. *Science* **272**: 1601-1606.
- Grigg, G., 1984.** Are kangaroos really under threat? *Australian Natural History* **21**: 123-129.
- Grigg, G., 1989.** Kangaroo harvesting and the conservation of arid and semi-arid rangelands. *Conservation Biology* **3**: 194-197.
- Grigg, G., 1995.** Kangaroo harvesting for conservation of rangelands, kangaroos...and graziers. Pp. 161-165 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. Centre for Conservation Biology, The University of Queensland, Brisbane.
- Grigg, G., Hale, P., Lunney, D. (eds), 1995.** *Conservation through sustainable use of wildlife.* Centre for Conservation Biology, The University of Queensland, Brisbane.
- Hale, P., 2001.** "Genetic effects of kangaroo harvesting". July 2001 Meeting on *Recent advances in scientific knowledge of kangaroos.* University of New South Wales, Sydney.

- Hasler, R., 1999.** *An overview of the social, ecological and economic achievements and challenges for Zimbabwe's CAMPFIRE Programme.* Evaluating Eden Series Discussion Paper No.3. International Institute for Environment and Development, London.
- Holdgate, M., 1992.** Can wildlife pay for itself? Royal Society of Arts London Symposium: <<http://www.connix.com/~harry/wildecon.txt>>.
- Holdgate, M., 1996.** *From care to action: making a sustainable world.* Earthscan Publications Ltd, London.
- Hood, J., 2001.** Cats and kids: the good news and the bad news. *The Veterinarian* **April 2001**: 1.
- Hopwood, P., 2001.** *Animal deliberations.* Sporting Shooters Association of Australia, Sydney.
- Horton, D., 2000.** *The pure state of nature: sacred cows, destructive myths and the environment.* Allen & Unwin, Sydney.
- Houston, D.B., Schreiner, E.E., 1995.** Alien species in National Parks: drawing lines in space and time. *Conservation Biology* **9**: 204-209.
- Hoy, A., 2001.** Cull of the wild. *The Bulletin* **April**: 34-36.
- Humphries, D., 2001.** Growing pains: population to hit 4.5 million eight years early. *Sydney Morning Herald* **7 Dec., 2001**.
- Hyde, K.W., 1998.** The new rural industries – a handbook for farmers and investors. RIRDC, Canberra.
- Isaacs, J., 1996.** *A companion guide to bush food.* Lansdowne, Sydney.
- IUCN, 1994.** Species Survival Commission. A member's guide 1994-1996 Triennium. Annex 2. Terms of reference of IUCN/SSC Disciplinary Specialist Groups. International Union for the Conservation of Nature.
- Jackson, S.T., Overpeck, J.T., 2000.** Responses of plant populations and communities to environmental changes of the late Quaternary. Pp. 194-220 in 'Deep Time: Paleobiology's perspective' ed. D.H. Erwin, S.L. Wing. *Paleobiology Supplement to Volume* **26(4)**.
- Jones, A., 2000.** Environmental impacts, human population size, and related ecological issues. Pp. 1-16 in 'Proceedings of the 10th Biennial Conference of the Australian Population Association Conference, Melbourne 2000. CD ISBN 0-9578572-0-9.
- Jones, A., 2001.** The Business Council of Australia's case for population growth: an ecological critique. *People and Place* **9**: 49-56.
- Jones, R., 1968.** The geographical background to the arrival of man in Australia and Tasmania. *Archives of Physical Anthropology in Oceania* **3**: 186-215.
- King, F.W., 1988.** Animal rights: a growing moral dilemma. *Animal Kingdom* **91**: 33-35.
- King, M., 1995.** Sustainable use—a hunter's concept. Pp. 282-287 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Kiss, A. (ed.), 1990.** *Living with wildlife: wildlife resource management with local participation in Africa.* World Bank Technical Paper 130, African Technical Department Series, The World Bank, Washington.
- Knudson, R., 1999.** Using the past to shape National Park Service policy for wildlife. *The George Wright Forum* **16**: 40-51.
- Lassak, E.V., McCarthy, T., 1983.** *Australian medicinal plants.* Methuen, Sydney.
- Latz, P., 1995.** *Bushfires and bushtucker: Aboriginal plant use in central Australia.* IAD Press, Alice Springs.
- Low, T., 1990.** *Bush medicine: a pharmacopoeia of natural remedies.* Angus & Robertson, Sydney.
- Low, T., 1991.** *Wild food plants of Australia.* Angus & Robertson, Sydney.
- Low, T., 1999.** *Feral futures.* Viking, Melbourne.
- Lowe, I., 1999.** Ranging marsupials against mutton. *New Scientist* **3 May**, Antipodes column.
- Lunney, D., 1995.** Kangaroo harvesting in the context of ecologically sustainable development (ESD) and biodiversity conservation. Pp. 166-175 in 'Conservation through sustainable use of wildlife' ed G.C. Grigg, P.T. Hale, D. Lunney. Centre for Conservation Biology, The University of Queensland, Brisbane.
- Lunney, D., 2001.** Causes of the extinction of native mammals of the Western Division of New South Wales: an ecological interpretation of the Nineteenth Century historical record. *Rangelands Journal* **23**: 44-70.
- Lunney, D., Pressey, B., Archer, M., Hand, S., Godthelp, H., Curtin, A., 1997.** Integrating ecology and economics: illustrating the need to resolve the conflicts of space and time. *Ecological Economics* **23**: 135-143.
- Marks, S., 1994.** *The imperial lion: human dimensions of wildlife management in central Africa.* Westview Press, Boulder.

- Martin, R.B., 1994.** Alternative approaches to sustainable use. What does and doesn't work. *Workshop 3 on Sustainable use of Renewable Natural Resources*. 19th Session of the IUCN General Assembly, Buenos Aires, Argentina, January 1994.
- McDonald, H.G., Chure, D.J., 2001.** The fossil record and contemporary problems in ecology: contributions from semi-deep time. Pp. 167-172 in 'Proceedings of the 6th fossil resource conference' ed. V.L. Santucci, L. McClelland. Geological Resources Division Technical Report NPS/NRGRD/GRDTR-01/01.
- McGowran, B., Archer, M., Bock, P., Darragh, T.A., Godthelp, H., Hageman, S., Hand, S.J., Hill, R., Li, Q., Maxwell, P.A., McNamara, K.J., Macphail, M., Mildenhall, D., Partridge, A.D., Richardson, J., Shafik, S., Truswell, E.M., Warne, M., 2001.** Australasian palaeobiogeography: the Palaeogene and Neogene record. *Memoir of the Association of Australasian Palaeontologists* 23: 405-470.
- McLeod, S., 2001.** "Alternative management strategies for harvesting kangaroos in the Murray Darling Basin". July 2001 Meeting 'Recent advances in scientific knowledge of kangaroos'. University of New South Wales, Sydney.
- McNeely, J.A., 1988.** Economics and biological diversity. Developing and using incentives to conserve biological resources. International Union for the Conservation of Nature, Gland.
- McNeil, R.J., McNeil, M.J., 1989.** Ownership of traditional information: moral and legal obligations to compensate for taking. *Northeast Indian Quarterly (Fall Issue)*: 30-35.
- Merrilees, D., 1968.** Man the destroyer: late Quaternary changes in the Australian marsupial fauna. *Journal and Proceedings of the Royal Society of Western Australia* 51: 1-24.
- Nations, J.D., 1992.** Xateros, chicleros, and pimenteros: harvesting renewable tropical forest resources in the Guatemala Peten. Pp. 208-219 in 'Conservation of Neotropical forests: working from traditional resource use' ed. K.H. Redford, C. Padoch. Columbia University Press, New York.
- Paddle, R., 2000.** *The last Tasmanian Tiger: the history and extinction of the Thylacine*. Cambridge University Press, Cambridge.
- Pain, S., 2000.** My pet possum. *New Scientist* 166(2236): 40-43.
- Pickard, J., 1990.** Attitudes and environmental use and management in the forgotten seventy per cent of Australia. *Australian Zoologist* 26: 54-58. Anon., 1991.
- Pople, A.R., Grigg, G.C., 1998.** Commercial harvesting of kangaroos in Australia. Unpublished document prepared for Environment Australia, Canberra. Available at the WWW: <http://www.environment.gov.au/bg/plants/wildlife/roo/toobg.htm>
- Pople, A.R., McLeod, S.R., 2000.** Kangaroo management and the sustainable use of rangelands. Pp. 78-86 in 'Management for sustainable ecosystems' ed. P.T. Hale, A. Petrie, D. Moloney, P. Sattler. The University of Queensland Press, Brisbane.
- Pratley, J., Robertson, A. (eds), 1998.** *Agriculture and the environmental imperative*. CSIRO Publishing, Collingwood.
- Pressey, R.L., 1995.** Conservation reserves in New South Wales: crown jewels or leftovers? *Search* 26: 47-51.
- Ramsay, B.J., 1994.** *Commercial use of wild animals in Australia*. Bureau of Resource Sciences, Department of Primary Industries and Energy, Australian Government Publishing Services, Canberra.
- Reithinger, R., 2001.** Topical insecticides control *Leishmania* reservoir dogs. BioMedNet News and Comment (<<http://news.bmn.com/commentary/back?uid=7920&printerready=yes>>).
- Rifkin, J., 1991.** *Beyond beef: the rise and fall of the cattle culture*. Penguin Press, New York.
- Roberts, J., Fisher, C., Gibson, R., 1995.** *A guide to traditional Aboriginal rainforest plant use*. Bamanga Bubu Ngadimunka Inc, Mossman.
- Roberts, R.G., Flannery, T.F., Ayliffe, L.K., Yoshida, H., Olley, J.M., Prideaux, G.J., Laslett, G.M., Baynes, A., Smith, M.A., Jones, R., Smith, B.L., 2001.** New ages for the last Australian megafauna: continent-wide extinction about 46,000 years ago. *Science* 292: 1888-1892.
- Rolls, E., 2000.** *Australia: a biography*. University of Queensland Press, Brisbane.
- RSPCA, 1985.** *Incidence of cruelty to kangaroos*. Report to Australian National Parks and Wildlife Service, Canberra.
- Sandall, R., 2001.** *The culture cult: designer tribalism and other essays*. Westview Press, Boulder.
- Sattler, P.S., 1995.** The greater conservation gain from a 'new' kangaroo industry for the mulga lands: ecologically sustainable management. Pp. 176-185 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Singer, P., Dover, B., Newkirk, 1991.** *Save the animals: 101 easy things you can do*. Angus & Robertson, Sydney.

- Stewart, K., Percival, B., 1997.** *Bush foods of New South Wales: a botanic record and an Aboriginal oral history*. Royal Botanic Gardens, Sydney.
- Swetham, T.W., Allen, C.D., Betancourt, J.L., 1999.** Applied historical ecology: using the past to manage for the future. *Ecological applications* 9: 1189-1206.
- Toyne, P., Farley, R., 2000.** *The decade of Landcare: looking backward - looking forward*. Discussion Paper No. 30. Australia Institute, Deakin ACT.
- Tunbridge, D., 1995.** Aspects of Aboriginals' traditional relationship to the environment. Pp. 35-44 in 'Conservation through sustainable use of wildlife' ed. G.C. Grigg, P.T. Hale, D. Lunney. The Centre for Conservation Biology, the University of Queensland, Brisbane.
- Vasquez, S., 2001.** A Quoll in the hand.... *The Veterinarian* September 2001: 10.
- Viggers, K.L., Lindenmayer, D.B., 2002.** Problems with keeping native Australian mammals as companion animals. Pp. xx-xx in (this volume). Royal Zoological Society of New South Wales, Sydney.
- Warren, M., 1992.** Indigenous knowledge, biodiversity conservation and development. Pp. 1-17 in 'International conference on conservation of biodiversity in Africa: local initiatives and institutional roles'. National Museums of Kenya, Nairobi.
- Webb, G.J.W., 1995.** The links between wildlife conservation and sustainable use. Pp. 15-20 in 'Conservation through sustainable use of wildlife' eds G.C. Grigg, P.T. Hale, D. Lunney. Centre for Conservation Biology, University of Queensland, Brisbane.
- White, M.E., 1997.** *Listen...our land is crying: Australia's environment: problems and solutions*. Kangaroo Press, Sydney.
- Williams, R., 2001.** *2001: a novel*. Hodder Australia, Sydney.
- Wilson, G.R., 1974.** The management of kangaroos. *Parks and Wildlife* 1: 111-119.
- Wilson, G.R., 1987.** Cultural values, conservation and management legislation. Pp. 250-265 in 'Fauna of Australia: general articles' ed. G.R. Dyne, D.W. Walton. Australian Government Publishing Service, Canberra.
- Wilson, G.R., 1988.** Improving the management of kangaroos. *Australian Zoologist* 24: 158-160.
- Woinarski, J.C.Z., Milne, D.J., Wanganeen, G., 2001.** Changes in mammal populations in relatively intact landscapes of Kakadu National Park, Northern Territory, Australia. *Austral Ecology* 26: 360-370.
- Wroe, S., Field, J., 2001.** Megafaunal mystery remains. *Australasian Science* 22: 21-25.