The neglected 74% - the non-threatened vertebrates - and a reflection on the limitations of the process that fashioned the current schedules of threatened species in New South Wales

Daniel Lunney[1], Alison Matthews[1], Hal Cogger[2], Chris Dickman[3]

[1]Department of Environment and Conservation (NSW), PO Box 1967, Hurstville NSW 2220

[2]John Evans Memorial Fellow, Australian Museum, c/- 2A Amethyst Ave, Pearl Beach NSW 2256

[3]Institute of Wildlife Research, School of Biological Sciences, University of Sydney, NSW 2006

ABSTRACT

In this chapter we apply an ecological approach to considering the vertebrate species listed on the current schedules of the NSW *Threatened Species Conservation Act 1995*. We do so in light of our knowledge of the threats that have impacted on the vertebrate fauna of NSW, but mainly as a reflection on our role as the Scientific Committee (1992-95) in formulating the schedules of threatened fauna under the *Endangered Fauna (Interim Protection) Act 1991*. We reflect on the limitations of this process, including constraints on time, a lack of adequate knowledge for most species and differences in expert opinion. The final 1992 list included 236 threatened vertebrate species, or 26% of the fauna of NSW. Threatened species have since been elevated by instruments of government and land-use decisions to such a degree that other species are apparently no longer of interest. Thus 74% of our vertebrate fauna has become neglected. Many species are missing out on research effort, and other conceptual approaches, such as threatening processes, are not given priority. In our opinion, the apparent immutability of the scheduled species is illogical given the uncertainty of the listing process, and we see a pressing need for a dynamic database of species status so that the schedules reflect new knowledge and changes in the status of species as they occur. Threatened species deserve special attention, but their relative importance in the wider conservation agenda needs re-examination if we are to fulfil the broader aims of conserving biodiversity.

Key words: threatened species, Scientific Committee, knowledge, fauna, frogs, legislation.

Introduction

When the NSW *Threatened Species Conservation Act 1995* was promulgated in December 1995, it contained two schedules of threatened vertebrate fauna. Schedule 1 contained taxa considered to be endangered, and Schedule 2 contained those judged to be vulnerable. These schedules were those listed under the *Endangered Fauna (Interim Protection) Act 1991*, the precursor to the *Threatened Species Conservation Act 1995*. The procedures and outcomes of that process have been presented elsewhere (Cogger and Lunney 1992; Lunney *et al.* 1996, 1997, 2000). The aims here are to reflect on the adequacy of that process, the apparently static nature of the schedules, and the consequences for the 74% of the vertebrate fauna not currently included in them. One could argue that the legislative process has fallen short of its own aims of conserving biodiversity by putting so much weight on conserving threatened species, thus relying on threatened species as a surrogate for other species. The process has not readily allowed for rapid changes to be made to any data set so that species can be removed from the schedules and others added on the basis of regular monitoring. The existing process now drives a major industry in environmental assessment, and the legislation has a great social impact because landowners must take account of threatened species in planned developments. An examination of some of the assumptions of that process is a requirement in an adaptive management environment, and the process under examination here is the selection of the species that were included in the NSW schedules of vertebrate fauna.

Saving species from the brink of extinction through legislative clout has provided a powerful instrument in helping to conserve our biological heritage. We remain committed to its retention and refinement. However, as ecologists, we see great merit in other approaches to conserving fauna, such as including all species in any study, survey or research program on the basis that different species yield different information about threatening processes, as well as habitat and area-based approaches (*e.g.* Margules and Pressey 2000; Pressey *et al.* 2002), evaluation of outcomes of threat mitigation, and long-term studies to conserve all our faunal diversity. The increasing priority afforded to threatened species, whether through legal obligation or a public sense of responsibility to conserve threatened species, tends to devalue the crucial role that the other 74% of vertebrates play in the conservation agenda (not to mention the invertebrates, *e.g.* Hutchings 2004). Further, as zoologists who have

Pp 145 - 157 in *Threatened species legislation: is it just an Act?* 2004, edited by Pat Hutchings, Daniel Lunney and Chris Dickman. Royal Zoological Society of New South Wales, Mosman, NSW, Australia.

spent much of our working lives becoming familiar with our fauna, and the people who have studied them, we are acutely aware of the limitations of our knowledge in producing definitive lists of threatened species. In this chapter, we revisit the schedules that we, as the initial Scientific Committee (Cogger, Dickman, Lunney), prepared in 1992, and we recall the uncertainty that accompanied our decision-making process. We support those legislative advances that incorporate populations and ecological communities in the *Threatened Species Conservation Act 1995* and the inclusion of threatened ecosystems in the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* but we focus here on the species schedules because of the weight that they are now given.

The *Endangered Fauna (Interim Protection) Act 1991*, and the neglected 74%

The NSW *Endangered Fauna (Interim Protection) Act 1991* provided a rare opportunity to move quickly to place species on the first-ever comprehensive NSW list of threatened vertebrate fauna. A modest list of endangered fauna had been part of the NSW *National Parks and Wildlife Act 1974*, but that schedule (Schedule 12) was drawn up without guidance in the Act as to criteria and did not provide for any regulatory mechanism beyond the protection afforded to all recognised vertebrate fauna (mammals, birds and reptiles), although there was an additional penalty attached to the harm of endangered fauna over protected fauna. One aim of the schedule was to draw attention to certain species and the concept of extinction. This was relevant to the NSW *Environmental Protection and Assessment Act 1979,* which required that endangered species be taken into account in relation to various matters that fell within its ambit. In contrast, the brief for the schedules of threatened fauna prepared under the *Endangered Fauna (Interim Protection) Act 1991* provided specific criteria for inclusion and a timetable for action – one month to produce the list, followed by a period of public review leading to finalisation of the list. The Scientific Committee was independent of parliament and ministers and the decisions of the Committee were final; they were not merely recommendations as had been the case with endangered species listed under schedule 12 of the NSW *National Parks and Wildlife Act 1974*.

The *Endangered Fauna (Interim Protection) Act 1991* passed through the NSW parliament in December 1991. The directions for action came to NSW National Parks and Wildlife Service (now part of the NSW Department of Environment and Conservation) in mid-January 1992 and the Committee of three, as specified under the Act, was promptly formed along with a small working team. A list of species was promulgated in a large daily newspaper (the *Sydney Morning Herald*) on 28 February 1992 as part of a statutory public review process. This publication activated the remainder of the Act, and the process of formally dealing with threatened species under their own legislation commenced for the first time in NSW. The review period was completed by August 1992 and the final decisions appeared in the *Government Gazette* on 18 December 1992.

Over the following three years the Committee received a few submissions for additions, but the listing procedure had become lengthy, and the few additions decided upon by the Committee were overtaken by the passing of the *Threatened Species Conservation Act 1995*. These few extra species, such as the Southern Hairy-nosed Wombat *Lasiorhinus latifrons*, were included in the new schedules, and they appeared in the *Threatened Species Conservation Act 1995* which passed through the NSW parliament in December 1995. Since the promulgation of the *Threatened Species Conservation Act 1995,* nine species of vertebrates have been added to the schedules and none removed (as of December 2003).

After the lists of NSW threatened species were promulgated at the beginning of 1992, the Committee members felt that we could be challenged legally in court to explain why some species were left off the schedules and why others were placed on the schedules. Such challenges could arise, for example, if a threatened species was located in the middle of a proposed development and was likely to impede it, or when an activity looked as if it would be widely damaging, even though no threatened species occurred on the site. In short, the demand to go to court could come from either side of the development debate. Further, we were acutely aware that the *Endangered Fauna (Interim Protection) Act 1991* had been passed through the NSW parliament by the Labor opposition and the independents against the wishes of the coalition government. While we could reasonably expect support from the government because parliament had passed the bill, we did not know the extent of government support if contentious cases reached the court. This issue of zoology in court had already been a matter of concern for the Royal Zoological Society of New South Wales (Lunney 1992). We did not relish the thought of court appearances because of the arguments that would inevitably arise about our treatment of uncertainty in assembling the lists and about whether the criteria in the Act could really be applied to a particular species if very little was known about it. However, these problems are largely overcome when rankings are derived from collective expert opinion, which is itself based on objective criteria; anyone wishing to challenge that ranking must be able to demonstrate that the available data negate that opinion. Rather, opponents to the listing of a particular species are forced to argue that the methodological approach (*e.g.* Millsap *et al.* 1990) is fundamentally flawed, an argument that is hard to sustain given the widespread acceptance by governments and biologists of this approach.

The requirement to produce the lists quickly might have resulted in some errors, but it did forestall any dithering. The brief period legislated for the preparation of the NSW lists in early 1992 has escaped many commentators. So, too, has the requirement in the legislation to consider all terrestrial vertebrate fauna (birds, frogs, mammals, reptiles) and provide the reasons for non-inclusion of a species as thoroughly as the reasons for inclusion. This required the Committee to prepare the first-ever list of NSW terrestrial vertebrates (a daunting task in itself) and then to justify the status assigned to every species, not just those likely to be included. What is so astonishing to us now is the apparent immutability, or even sacredness, of the schedules as they are embedded in the workings of so

many instruments of government and land-use decisions. At the time, we were not aiming to produce a once-only definitive list, based on universally-agreed criteria, of species about which we had perfect knowledge. Problems arise as the scheduled 26% of threatened species drift away from the other 74% of the fauna. We have to devise ways to conserve species not listed under legislation, but which also are in need of special attention, and to address the threats to them and their habitats.

Threatened species deserve close attention but, in our opinion, they represent only one limited component of an effective biodiversity conservation program. Further, the nature of the legislative process means that it rarely keeps pace with rapid changes in the status of species and ecosystems. Consequently, the concept of threatened species legislation and its application need regular revisiting if we are to become more effective in conserving biodiversity. With 74% of the vertebrate fauna of NSW not listed on the schedules of threatened species in 1992 (Lunney *et al.* 1996, 2000), there is a case for considering the status of these outsiders. One thesis pursued here is that they have become a neglected portion of our vertebrate fauna. This matter is highlighted when you consider the nature of the system involved in placing species on, or removing them from, the schedules. There is a pressing need for a dynamic database of species' status so that the schedules rapidly reflect new knowledge and the consequent changes in a species' status. These matters have been identified as being among the nation's highest faunal research priorities (ANZECC/BDAC 2001). Priority 2 of that report – identifying Australia's species – states that the highest priority research includes the need to 'identify, characterise and record the distribution of native species that are or may be threatened'. Research priority 3 – monitoring changes in Australia's biodiversity – is given the highest priority to 'develop and validate methods for direct measures and indicators to monitor the distribution and abundance of species'. Both research priorities stress the need for biodiversity condition to be part of the state of the environment reporting. We argue that monitoring the lists is an essential activity which needs to be supported by a sustained research program with the capacity to regularly revise the schedules. That they need to be revised is apparent to us as we revisit the procedures and lists we prepared in 1992.

In our view, the current threatened species paradigm for conserving biodiversity subverts the original aim of listing threatened species as symbols of the loss of biodiversity and as case studies of the many processes that lead to extinction. It appears to have become a dominating end in itself in that threatened species provide touchstones in a variety of crucial documents that determine national, state and local priorities for biodiversity conservation. The legal requirement to conserve threatened species is respected in such documents, but the need to see this approach as indicative of the broader picture does not emerge from our reading of them. This paradigm manifests itself through the emphasis on survey, monitoring and research of threatened species in such major programs as the Comprehensive Regional Assessments (CRA) under the National Forest Policy Statement (Commonwealth of Australia 1992), and in regulations and court action, or threats of action, that focus on threatened species in development applications. Threatened species have been elevated to such a degree that other species are virtually overlooked. For example, data audits have in the past resulted in threatened species being the only species entered on the Atlas of NSW Wildlife. Threatened species are also the only species subject to pre-logging surveys in the Integrated Forestry Operation Approvals (IFOA) process, which is part of the Regional Forest Agreement (RFA) process, yet threatened species are only just over a quarter of the vertebrate fauna. We point out, that because threatened species usually occur in low numbers, most are not suitable for long-term monitoring programs. Such programs require species that can be found in sufficient numbers to enable an effective monitoring program to be designed (*e.g.* Lunney and Matthews 2004). Moreover, it is critical that we do not treat threatened species simply as those species most deserving of our conservation effort, but rather as early indicators of failing systems – both ecological and social.

Our contention is that it is ecologically more informative and rigorous to conserve biodiversity as a whole by examining and minimising existing and potential threatening processes, such as land clearing, inappropriate fire regimes, logging, roading, toxic waste, salinity, overgrazing, pest species, and disruption to the natural flows of water. Lunney *et al.* (2003) made this point for bats, where national priorities concentrate almost exclusively on a small number of threatened species (9 of 90 taxa) and omit general bat research. These authors suggested that a better approach would be to focus on the threatening processes that affect all bat species, such as logging, management of old mines and identification and protection of roosts, in order to simultaneously determine strategies for protecting those bats that are threatened, as well as instituting measures that will prevent others from declining significantly. In our view, the effort devoted to the threatened species agenda can work, albeit unintentionally, to the detriment of a more holistic approach in conservation as well as to threatened species themselves. For example, the presence of a threatened species was not intended to block all developments on all sites. If threatened species are used regularly to stop developments, then efforts will be made to limit species being included on the schedules, and the process of identifying and conserving biodiversity will begin to fail. The converse can also apply. For example, some people may fear removing a species from a schedule. It seems that the more the schedules are used as planning tools the further we move from the intent of using them to implement more effective conservation programs.

At issue for the neglected 74% of the vertebrate species not on the schedules is that these species do not attract attention for funding, which is directed almost entirely towards threatened species. How then can a comprehensive review be carried out? Consider the following story. In 1989, a small group of us in the research branch of the NSW National Parks and Wildlife Service applied to the Australian National Parks and Wildlife Service (a forerunner to today's Commonwealth Department of Environment and Heritage) for a grant to study the Spotted-tailed Quoll *Dasyurus maculatus* and examine its status in NSW. The application for funding was automatically rejected because this species was not on the national list of threatened species. It was subsequently listed on the national register and began to

receive special attention under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. In 1992, the Spotted-tailed Quoll was listed in NSW under the *Endangered Fauna (Interim Protection) Act 1991*, and holds this status under the replacement Act, the *Threatened Species Conservation Act 1995*. In NSW, it is now a species that gains much attention and is the subject of some careful research (*e.g.* Belcher 2004; Körtner *et al.* 2003). On 14 May 2004 it was listed nationally as endangered, and is now recognised as being just one step from extinction. This is a dramatic change in 15 years. How naïve of us to apply for funding for research on a non-threatened species, even if it was to review its status! The first lesson of this story is the recognition of a barrier between those species on the lists and those not on the lists. The next lesson is that the Spotted-tailed Quoll was undoubtedly a species in trouble in 1989. Concerted action for its conservation had to wait until official listing, yet with its congener, the Eastern Quoll *D. viverrinus*, already extinct on the mainland (it is extant only in Tasmania), there was a strong case for research into its status in 1989. The most powerful lesson is to heed the call for species monitoring at the highest level (that is, in validation of management programs, not just compliance), supported by dynamic databases (in which newly-acquired knowledge about a given species is quickly incorporated into the database and an automatic (quantitative) reassessment of its conservation status generated), dedicated staff and a regard for the schedules of threatened species as part of a commitment to adaptive management. Threatened species legislation has helped focus attention on the plight of *Dasyurus maculatus*, and this is an example of the positive value of such legislation. The converse is that unlisted species are out of sight as far as their conservation is concerned.

We thus urge the adoption of a dynamic system of revising the schedules and a commitment to its rolling application. Revision of the schedules needs to be undertaken at least every five years. The process can look at trends in a community, and monitoring can pick up species not on the list. The lists need to be ranked on objective criteria, the ranking to be dynamic as required by good governance, and have provision for alerting relevant authorities. For example, one of us (Cogger) has proposed what seems to be a simple system to trigger the federal environment minister to take action if a development application affects a species that has been flagged under objective criteria, even if the values are estimates. Criteria with a red flag include, for example, those species in which the total area once occupied by the species is known or is suspected to have declined by more than 75%, with other criteria marked by red or yellow flags. The alert for the minister to consider action in relation to a particular development would be the presence of at least one red flag or two yellow flags. The red, amber and green light approach was a feature of the NSW State of the Environment report 2003, and it has been the subject of comedy in the USA in relation to terrorist alerts. However, the idea is sound. The colour of the flags could change, and we hope that this is the only impediment to a trial of their use. Without a categorical early warning system, it is utterly predictable that tempers will become frayed if a government acts too late, and without having given a developer the information in good time. Such a system, with its unambiguous flags, is easily adaptable to internet use and has the advantage of simplicity. It does, however, require a dynamic database which includes geographic range and habitat information as well as population levels.

The uncertainty in the 1992 lists

This section critically examines how the official lists of threatened vertebrate species in NSW were prepared. We aim to loosen the perceptibly growing rigidity in the application of the schedule, as well as to challenge the growing dominance of threatened species in programs to conserve our fauna.

When the 1992 lists were prepared we were acutely aware of the lack of adequate information on which to base them. In part, we avoided the worst aspects of that problem by consulting experts for each species, or group of species. We asked each expert to tick a score sheet for each species. The criteria were ecological, most were numerical, and the method followed that of Millsap *et al.* (1990), modified for NSW. Cogger *et al.* (1993) had already found that it was a valuable method in the preparation of the national reptile action plan. We then asked each expert to examine the reasons listed in the Act, such as 'whether the habitat of a species has been drastically reduced or modified' (1 of 5 criteria to qualify for endangered), or 'whether the population of a species is still abundant but is under threat from severe adverse factors throughout its range' (1 of the 5 criteria to qualify for vulnerable).

Each expert was to tick 'yes' or 'no' as to whether the species they were commenting on fitted the criteria and should be listed as either endangered or vulnerable, and if there was no tick, then the species would remain protected (under the NSW *National Parks and Wildlife Act 1974* – see Jarman and Brock 2004) but not on the list of threatened species. We selected experts on the basis of our personal knowledge of the individual as well as our reading of the scientific literature and our own knowledge of the vertebrate fauna. We did not confine ourselves to one expert, but selected many experts (89 people for 883 species), and for those species where the decision was likely to be disputed or close to the line, we selected up to 11 experts. The number who responded and provided assessments for each species is given in Lunney *et al.* (2000). We also asked each expert whether they felt that their knowledge base for deciding was A (adequate), B (limited), or C (inadequate). Lunney *et al.* (2000) also recorded when there was a difference of expert opinion about whether a species should be listed or not.

The responses showed there was adequate knowledge for only 6% of species, limited knowledge for 42%, and inadequate knowledge for 52% of species, with noticeable differences in the proportions within each vertebrate class (Figure 1). Despite these knowledge limitations, 26% of species were placed on the list of threatened species. It follows that we were operating under a high level of uncertainty with respect to knowledge in preparing the lists. The second element of uncertainty arises when one considers the responses to the option given to each expert as to whether a species should be listed or not.

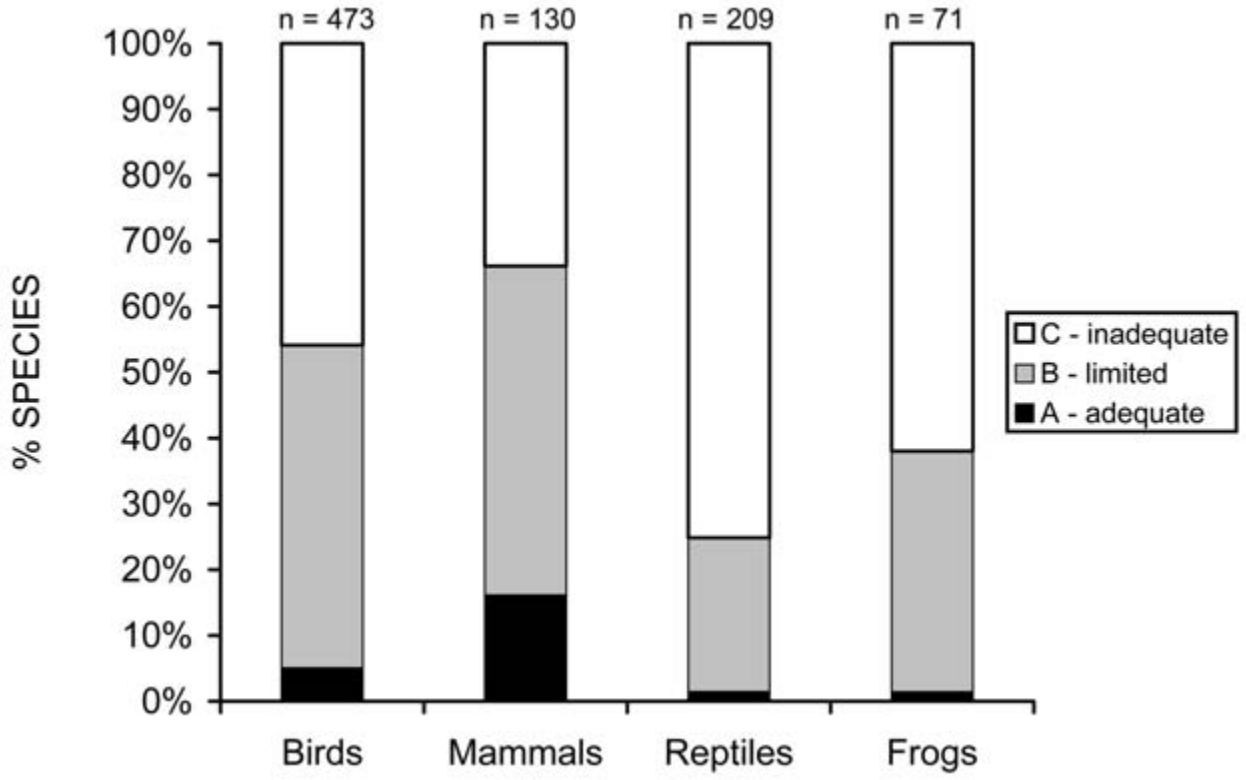

Figure 1. Levels of knowledge in the 1992 evaluation of vertebrate fauna. Percentage of birds, mammals, reptiles and frogs with levels of knowledge from 1992 evaluation. Reptiles and frogs had poor level of knowledge compared with birds and mammals. Overall 'adequate' levels of knowledge on which to assess status of species was low.

Results for each species, and any disagreement (or not) among the experts, were marked in separate columns in the relevant table in Lunney *et al.* (2000). The number of species for which there was disagreement among the experts is shown in Table 1 here. This table was split into the four classes of terrestrial vertebrates. It was also divided into the three categories of knowledge within each vertebrate class. One of the columns shows the percentage of species in each class so that comparisons can be made among the classes. From this table it might be noted that as the level of knowledge declined, the level of disagreement rose (*i.e.* expert opinion became more subjective, being a 'best guess' based not only on available knowledge but also on extrapolation from knowledge of related taxa, anecdotal information, and personal knowledge of habitat preferences). The overall trend is shown in the combined total of all species. The extent of disagreement among the experts was most marked for frogs and reptiles, evident for birds, and least for mammals. For mammals, the percentage disagreement was highest in the limited category. Thus there is a class difference among the vertebrates in relation to knowledge and expert opinion, in large part due to a combination of taxonomic diversity and the size of the research base (number of researchers). Notwithstanding such differences, the standout message for us in this table is that variance in expert opinion is inversely related to the knowledge base. It follows that, since adequate knowledge is the smallest category, and inadequate knowledge the largest, then disagreement is going to be widespread and pervasive.

As zoologists, we can point to the major gaps in knowledge of our fauna, even of the vertebrates, which are numerically insignificant compared with our invertebrate fauna. From a policy perspective (whether legal, bureaucratic or NGO threatened species activist), matters to be challenged include the legislative inflexibility of the schedules, the rigidity with which they have been applied to funding decisions, the setting of priority actions for conservation, and the limited role of experts, especially when forced to cope with incomplete or inadequate knowledge on which to make a categorical decision about a species' status. However, in defence of the expert system, if the species had been allocated randomly from a group of non-experts, the level of disagreement would be 100%. Overall, it was 26%, but with frogs at 57% when the level of knowledge was inadequate, even a non-frog expert could conclude that frogs are a group that should be revisited. We believe that the only way in which these problems can be adequately addressed is through linking dynamic databases on taxa and ecosystems to legislation, either by incorporating such databases into the legislative process (which is probably impractical) or by making them formal instruments to guide regulations and ministerial decision-making.

We also note that if the only species listed were those with a unanimous vote for listing, then the lists would have been halved. Conversely, if we had listed all species that at least one expert thought warranted inclusion, the list would have been half as long again. The final list of 233 species was about half way between the two outer limits (127 and 353 species) of what could have been

Table 1. The number of species for which expert opinion differed as to status in relation to the level of knowledge for the species.

Note: the total numbers of species (883) are those assessed in 1992 and listed in Table 1 of Lunney *et al.* (2000); by November 2000 there were a total of 891 species known from New South Wales (Lunney *et al.* 2000).

Level of knowledge	Number of species	Expert opinion differs	
		n	%
Birds			
A – adequate	24	0	0
B – limited	232	40	17
C – inadequate	217	54	25
Total	473	94	20
Mammals			
A – adequate	21	1	5
B – limited	65	19	29
C – inadequate	44	10	23
Total	130	30	23
Reptiles			
A – adequate	3	0	0
B – limited	49	12	24
C – inadequate	157	59	38
Total	209	71	34
Frogs			
A – adequate	1	0	0
B – limited	26	9	35
C – inadequate	44	25	57
Total	71	34	48
All species			
A – adequate	49	1	2
B – limited	372	80	22
C – inadequate	462	148	32
Total	883	229	26

deemed acceptable, giving a range from 14% to 40% of the vertebrate fauna listed as threatened. *Inter alia*, this reflected the application of the criterion in the Act that, 'the Committee is to have regard to …(e) any other matter which the Committee considers relevant', as well as the substantial use we made of the numerical scoring procedure. However, since we did not use numbers as a cut-off point, then the decision to list or not list reflects our expert judgment in relation to each individual score and the weight of expert opinion. We thus have two layers of expert opinion, with the Committee's expertise being a combination of the numerical and voting scores provided by the experts, guided by our own local knowledge of the fauna, the experts and the relevant scientific literature.

A variety of decisions could have been applied to the data we obtained in constructing the lists, ranging from the conservative to the speculative. For example, we could have required unanimity among the experts to proceed to a listing, used just one vote for listing, or given most weight to the Committee's own expertise. In practice, the Committee adjudicated on the range of opinions among the experts. When we now examine the differences among the vertebrate classes, we note that the reptiles show an 8-fold difference among 80 species that would have been listed with a decision to give the highest rank to listing, compared to 10 by the most cautious decision (Table 2). The Committee settled on 27 species of reptiles. The decision-making for the frogs is also instructive. By using the conservative criteria, i.e. the lowest alternative, only seven species would have been listed, and none would have been called endangered. In the end, four frog species were listed as endangered and the dramatic rise to fame of the Green and Golden Bell Frog *Litoria aurea* was underway (*e.g.* Goldingay 1996; Greer 1996; Pyke and Osborne 1996; Pyke and White 2001; Christy 2003).

Table 2. Comparison of the number of species listed with possible outcomes if alternative criteria were used.

Highest alternative – includes species where at least one expert nominated listing. Lowest alternative – includes species only where all experts agreed on listing. Endangered category here includes extinct species.

Listed category	Listed 1992	Highest alternative	Lowest alternative
Birds			
Protected	363	331	425
Vulnerable	78	86	33
Endangered	32	56	15
Total	473	473	473
Mammals			
Protected	53	38	68
Vulnerable	40	39	33
Endangered	37	53	29
Total	130	130	130
Reptiles			
Protected	182	129	199
Vulnerable	23	69	10
Endangered	4	11	0
Total	209	209	209
Frogs			
Protected	52	32	64
Vulnerable	15	24	7
Endangered	4	15	0
Total	71	71	71
All species			
Protected	650	530	756
Vulnerable	156	218	83
Endangered	77	135	44
Total	883	883	883

The special case of frogs

In 1991, frogs were not considered to be fauna under the NSW *National Parks and Wildlife Act 1974*. Fauna until then comprised just three classes of vertebrates (birds, mammals and reptiles). In fact, reptiles have enjoyed legislative recognition only since 1974 with the passage of the *National Parks and Wildlife Act 1974*. Thus, in 1992 the NPWS did not have a corporate working knowledge of frogs, and it had to rely on the skills and collections at the Australian Museum, as well as local expertise, expressed, for example, in the books of Barker and Grigg 1977 and Barker *et al.* 1995 (which was then in the pipeline). The surprise inclusion of frogs as fauna under the legislation has been commented on previously (*e.g.* Cogger and Lunney 1992; Lunney and Ayers 1993), but what emerged was a new way of looking at the world. However, recent reviews on frogs have changed our perception on which species should be on the lists.

In 2001-2003, under the auspices of WWF (Australia) and Rio Tinto through their Frogs! partnership program, a review was conducted of the frogs of Australia by the program's Scientific Panel, on which one of us (Cogger) sat. A modified version (to reflect the special biological and ecological features of frogs) of the Australian Reptile Action Plan (Cogger *et al.* 1993) was adopted. Subsequently a small group of specialists was convened to complete the final iteration of a Millsap analysis of all Australian frogs in May 2003, producing results and a ranking of threatened frogs that varied in fairly minor respects from those determined by the Scientific Panel alone. The latter results are cited in Table 3. However, one needs to bear in mind that these scores cannot be compared directly with the 1992 NSW scores. As already indicated, the Millsap criteria were revised for the 2003 scores to better match frog biology and ecology. Further, being a national ranking, the criteria used were applied at a different geographic scale to those used in the NSW analysis. Nevertheless, retaining the Millsap scoring system makes it easier to analyse the new results using Millsap's suite of statistical tests, as well as to make comparisons with earlier data sets. The NSW subset of the 2003 WWF review was constructed to make a comparison with the 1992 status listings for frogs in NSW (shown in Table 3).

The frogs are ranked in Table 3 according to their Millsap score in early 2003. Their 1992 NSW status is presented in the next column. Some discrepancies become immediately apparent. The changes in status in NSW since 1992 are presented in the final column, and some movement towards the WWF 2003 position can be seen. What stands out as particularly odd in this table is the 1997 Australian Frog Action Plan (Tyler 1997). One notices that the current rankings are not well aligned with the 1997 Frog Action Plan, which was based, ultimately, on the subjective views of an unknown number of people (after lots of input from others). Further, it was not based on any published suite of objective criteria, but the Frog Action Plan states (p.4) that the IUCN criteria that then applied were adopted, and the definitions of these categories were repeated in the Action Plan. The main issues are that (1) the reasons for the decisions to place a species in a particular category were not transparent (*i.e.* the application of the IUCN criteria to each taxon

Table 3. Threatened frogs in New South Wales. Rank – from a 2003 assessment by the WWF Frogs! Panel using Millsap biological scores. 1992 NPWS Millsap Assessment (Lunney *et al.* 2000) used to derive threatened species listing in NSW under the *Endangered Fauna (Interim Protection) Act* 1991 and then transferred under the *Threatened Species Conservation Act*, 1995. 2003 NSW – identifies changes to the NSW threatened species listing since 1992.

Rank (NSW only)	NSW Frog Species	1992 NPWS Millsap Assessment	1997 Aust Frog Action Plan	2003 WWF Frogs! Panel Millsap Score (biological criteria only)	2003 NSW (changes since 1992)
1	*Pseudophryne corroboree* ^	Vulnerable	Endangered	65	Endangered
2	*Adelotus brevis* *	At least one expert nomination	unlisted	53	Endangered population β
3	*Litoria castanea* ^	Endangered	Endangered	52	
4	*Litoria spenceri* ^	Endangered	Endangered	51	
5	*Litoria piperata* ^	Vulnerable	Vulnerable	50	
6	*Pseudophryne pengilleyi*	not considered	of concern; insufficiently known	49	Vulnerable
7	*Mixophyes iteratus* ^	Vulnerable	Endangered	44.3	Endangered
8	*Mixophyes fleayi* ^	Vulnerable	Endangered	44	Endangered
9	*Crinia tinnula* ^	Vulnerable	of concern; insufficiently known	38	
10	*Litoria aurea* ^	Endangered	Endangered	37	

Rank	NSW Frog Species	1992 NPWS Millsap Assessment	1997 Aust Frog Action Plan	2003 WWF Frogs! Panel Millsap Score	2003 NSW
11	*Assa darlingtoni* ^	Vulnerable	Unlisted	36	
11	*Heleioporus australiacus* ^	Vulnerable	of concern; insufficiently known	36	
11	*Mixophyes balbus* ^	Vulnerable	Vulnerable	36	Endangered
11	*Litoria booroolongensis* *	At least one expert nomination	of concern; insufficiently known	36	Endangered
12	*Pseudophryne australis* ^	Vulnerable	of concern; insufficiently known	35	
13	*Litoria subglandulosa* ^	Vulnerable	of concern; insufficiently known	34	
14	*Philoria loveridgei* ^ φ	Vulnerable	unlisted	33	
14	*Philoria sphagnicolus* ^ φ	Vulnerable	of concern; insufficiently known	33	
15	*Litoria olongburensis* ^	Vulnerable	Vulnerable	32	
16	*Philoria kundagungan* ^	Vulnerable	unlisted	31	
16	*Litoria freycineti* *	At least one expert nomination	of concern; insufficiently known	31	
17	*Litoria revelata* *	At least one expert nomination	unlisted	27	
18	*Litoria raniformis* ^	Endangered	Vulnerable	24	
18	*Litoria pearsoniana* *	At least one expert nomination	of concern; insufficiently known	24	
18	*Notaden bennettii*	No expert nomination	unlisted	24	
19	*Crinia sloanei* *	At least one expert nomination	unlisted	23	
10	*Pseudophryne bibronii*	No expert nomination	of concern; insufficiently known	21	
21	*Limnodynastes interioris* *	At least one expert nomination	unlisted	20	
22	*Cyclorana verrucosa* *	At least one expert nomination	unlisted	19	
23	*Lechriodus fletcheri* *	At least one expert nomination	unlisted	18	
23	*Pseudophryne dendyi* *	At least one expert nomination	unlisted	18	
23	*Litoria citropa*	No expert nomination	unlisted	18	
24	*Cyclorana platycephala*	No expert nomination	unlisted	17	
24	*Geocrinia victoriana*	No expert nomination	unlisted	17	
25	*Limnodynastes terraereginae* *	At least one expert nomination	unlisted	16	
25	*Pseudophryne coriacea*	No expert nomination	unlisted	16	
25	*Uperoleia fusca*	No expert nomination	unlisted	16	
26	*Limnodynastes salmini* *	At least one expert nomination	unlisted	15	
26	*Paracrinia haswelli* *	At least one expert nomination	unlisted	15	
26	*Litoria alboguttata* *	At least one expert nomination	unlisted	15	
26	*Crinia parinsignifera*	No expert nomination	unlisted	15	

Rank	NSW Frog Species	1992 NPWS Millsap Assessment	1997 Aust Frog Action Plan	2003 WWF Frogs! Panel Millsap Score	2003 NSW
26	*Litoria dentata*	No expert nomination	unlisted	15	
26	*Uperoleia tyleri*	No expert nomination	unlisted	15	
27	*Litoria brevipalmata* ^	Vulnerable	of concern; insufficiently known	14	
27	*Limnodynastes fletcheri*	No expert nomination	unlisted	14	
27	*Uperoleia laevigata*	No expert nomination	unlisted	14	
28	*Litoria jervisiensis* *	At least one expert nomination	unlisted	13	
28	*Cyclorana novaehollandiae*	No expert nomination	unlisted	13	
28	*Litoria chloris*	No expert nomination	unlisted	13	
28	*Litoria phyllochroa*	No expert nomination	unlisted	13	
29	*Limnodynastes dumerilii*	No expert nomination	unlisted	12	
29	*Limnodynastes tasmaniensis*	No expert nomination	unlisted	12	
29	*Uperoleia rugosa*	No expert nomination	unlisted	12	
30	*Neobatrachus sudelli*	No expert nomination	unlisted	11	
31	*Mixophyes fasciolatus* *	At least one expert nomination	unlisted	10	
31	*Litoria lesueuri* ψ	No expert nomination	unlisted	10	
31	*Uperoleia capitulata*	No expert nomination	unlisted	10	
32	*Litoria gracilenta* *	At least one expert nomination	unlisted	9	
33	*Crinia signifera*	No expert nomination	unlisted	8	
33	*Limnodynastes peronii*	No expert nomination	unlisted	8	
33	*Litoria latopalmata*	No expert nomination	unlisted	8	
33	*Litoria tyleri*	No expert nomination	unlisted	8	
34	*Litoria caerulea* *	At least one expert nomination	unlisted	7	
34	*Litoria nasuta* *	At least one expert nomination	unlisted	7	
34	*Litoria peronii*	No expert nomination	unlisted	7	
34	*Litoria verreauxii*	No expert nomination	unlisted	7	Sub-species *L. v. alpina* Endangered
35	*Litoria fallax* *	At least one expert nomination	unlisted	6	
35	*Crinia deserticola*	No expert nomination	unlisted	6	
35	*Limnodynastes ornatus*	No expert nomination	unlisted	6	
36	*Litoria ewingii* *	At least one expert nomination	unlisted	4	
36	*Litoria rubella*	No expert nomination	unlisted	4	
	Neobatrachus centralis	No expert nomination	unlisted		

Rank	NSW Frog Species	1992 NPWS Millsap Assessment	1997 Aust Frog Action Plan	2003 WWF Frogs! Panel Millsap Score	2003 NSW
	Litoria daviesae #				Vulnerable
	Litoria littlejohni #				Vulnerable
	Neobatrachus pictus ϕ				Endangered

^ Assigned threatened status in 1992

* At least one expert nomination in 1992

Previously undescribed species

ϕ Previously unknown in NSW

β Nandewar and New England Tablelands Bioregion endangered population of *Adelotus brevis*

φ Some populations of *Philoria loveridgei* and *P. sphagnicola* are now assigned to *P. kundagungan, P. pughi* and *P. richmondensis* (Knowles *et al.* 2004)

ψ 1992 NSW populations of *Litoria lesueuri* have variously been assigned to *L. lesueuri, L. wilcoxi* Günther, 1864 and to hybrid populations by Donnellan and Mahony (2004)

was not published), and (2) the IUCN criteria are global in context, and so do not necessarily reflect national priorities. The use of a scoring procedure such as Millsap *et al.* (1990) can help overcome such difficulties as seen in the Frog Action Plan.

The extent to which the current status of each frog taxon differs from earlier assessments can be seen from the extent to which the status assessments between the columns are mixed up, but with the caveat that a difference of only 2 or 3 points in the scores (on which the rankings are based) is not statistically significant. The taxa worth pointing out are those that have serious discrepancies, such as *Litoria brevipalmata, Adelotus brevis, Pseudophryne bibronii* and *Notaden bennetti.* A further major caveat is that the comparison can be based only on rankings (not threatened status) and these will vary with scale, especially where rankings are not based on the total geographic range of a species. Thus a species whose range in NSW is marginal (*i.e.* it represents only a small part of its total range) will be likely to be assigned elevated threatened status (or ranking) by comparison with the ranking of the same species when total geographic ranges are considered. This is not necessarily a criticism of state rankings, but in most cases a reflection of the interaction of two major criteria – the size of a species' geographic range under consideration and the extent to which that range is itself subject to major threatening processes, such as land clearing and overgrazing.

In relation to the inadequacies of the current threatened species legislation (NSW TSC Act and the Commonwealth EPBC Act), and the manner in which the courts apply them, the concerns now for frogs (and indeed many other vertebrates) are that all legislative instruments fail to take sufficient account of (a) incremental loss of habitat through the tyranny of small decisions; (b) scale of development; (c) edge effects and other effects of fragmentation; (d) the need for buffer zones in many cases, especially those affecting wetlands; and (e) the fact that the number of humans interacting with natural systems post-development is a critical factor in assessing impacts and in reducing their effects through good design and the use of technological solutions (such as fences).

Public attention for threatened species

Threatened species legislation in large part pivots on the view (as encapsulated in the IUCN category definitions) that an endangered species is one category away from the extinct species list and a vulnerable species is heading towards the endangered species list. The message that is loud and clear to the general public is that species can decline to the point of being endangered and that if remedial action is not taken, then the decline will continue to extinction. The Numbat *Myrmecobius fasciatus* is an icon species for Western Australia. Yet few know that it was a NSW resident at the time of European settlement. The Numbat is now one of the state's 27 species of mammals that has slid to extinction since 1788 and is one of 24 mammal species that became extinct in western NSW in the first 60 years of European occupation

of that area. Some of the other native mammals, such as the Pig-footed Bandicoot *Chaeropus ecaudatus*, have not only disappeared from western NSW, but from Australia. The cause of the extinction of the mammals of western NSW can be found in the overwhelming changes to the land wrought by sheep and compounded by the rabbits and foxes that followed in their wake. The impact was so profound that a Royal Commission on the Western Lands was formed and in 1901 it handed in its report on the causes and consequences of the use, or rather overuse, of the arid and semi-arid lands of NSW. The views found in that report can be interpreted ecologically to help explain one of the greatest mass extinction episodes of the modern era (*e.g.* Griffiths 2001; Lunney 1994, 2001; Noble 2001).

The catchcry that 'extinction is forever' has a powerful appeal, but the billboard invitation by the Australian Museum in 2003, to come and see the Thylacine 'while it is still extinct', carried an even more powerful message. If as yet undiscovered genetic technology can clone a Thylacine *Thylacinus cynocephalus* from tissue of a specimen in the museum, the cost will be immense. The important message is to conserve a species while it is extant and the extension of that message is to prevent its decline. Reversing a serious and rapid decline is likely to be a monumental task. In seizing public attention, the iconic threatened and extinct species, in our opinion, have done a brilliant public relations job for threatened species. Koalas, for example, have been a great icon for conserving forested land that is not in public ownership (*e.g.* Hamilton *et al.* 2000; Lunney *et al.* 2002). This task would have been less effective if the Koala had not been on the threatened species list. Thus there has been a positive value in working with a threatened species, but the Koala did not have this status in NSW when the work started (Lunney *et al.* 1990).

The most broadly threatened mammalian group in NSW is the rodents (Dickman *et al.* 2000). Many species are threatened or extinct, but some are sufficiently widespread to fulfil another primary goal for conservation – that is, to serve as subjects of an evaluation of threats, including potential for recovery, through experimental design and not just anecdotal information. We must be fundamentally committed to a measurable sense of recovery (or impact), for which experimental approaches such as replicated, balanced designs can be employed. Without such a commitment to monitoring and investigation at this high level of endeavour, there will be too much guesswork, or prejudice, about impacts or recovery. The best species to work with are those, such as the Bush Rat *Rattus fuscipes*, that are sufficiently common to provide estimates of numbers. These are not threatened species; they belong in the 74% bracket. What we are arguing is that good conservation practice demands good science, and good science demands good experimental design, which can rarely be provided by threatened species simply because their populations are usually too small to be studied meaningfully. So, the other 74% is the best group to employ in studies aimed at conserving habitats, defining and curbing the threatening processes, and evaluating recovery.

Conclusion

The monograph by Lunney *et al.* (2000) explained how we arrived at the 1992 lists of threatened and non-threatened native vertebrate fauna of NSW. The aim here is to emphasise the level of uncertainty we encountered as we prepared the lists in 1992, and to present our reflections on those levels of uncertainty. We also consider the deleterious ecological consequences of investing most conservation effort in threatened species, rather than taking a holistic approach that deals with threatening processes for all fauna. The threatened species lists have been a boon for conserving biodiversity, but they should not become an impediment to other intelligent and essential approaches to the difficult task of conserving all our native fauna. Nor should the lists, and the procedures that led to their formulation, remain static. Inadequate knowledge undermines the listings, but how do we increase our knowledge? It is not, we would argue, by looking only at the species on the list. We need to take a more ecological approach and reflect on the broader aim of conserving biodiversity, not just of those species currently on the threatened species schedules. The report, *Biodiversity Conservation Research: Australia's Priorities*, provides one intelligent approach as to what to do, and we note that determining lists of threatened species is an outcome of a monitoring process, not simply a self-contained aim (ANZECC/BDAC 2001). We emphasise this so that others will look critically at the schedules, and the methods, and come up with imaginative solutions for new ways to conserve our fauna, and not just work from an historic list that lacks the latest information. We also need to minimise the time lag between the identification of significant declines (or recoveries) and the updating of legislative schedules to reflect those changes.

The primary conclusion from this analysis is that the current NSW schedules of threatened species were produced with a recognition of the limitations of the methods, and the knowledge and the time available. This recognition was reflected in the inclusion of three measures of variability (level of knowledge, differences in expert opinion, and final judgement by the Committee, which included the numerical scores for each species). These measures can be interpreted in a number of ways, and as few as 127 species, or as many as 353 species could have been listed as a result of the exercise. The final 1992 list was 236 species, or 26% of the fauna. Consequently, we need to consider the lists as approximations, as working lists in need of revision, and not immutable, and certainly not as definitive. Frogs highlight one element of the problem. If one chose to tighten or relax the criteria for inclusion of species on the schedules, then one could simply move a marker up or down a set of species fixed in ranked order of degree of threat. But these rankings will vary over time – often over very short periods – as new information about the status of particular species and their distribution and ecosystems comes to hand through research or observations. The draft 2004 WWF-funded revision of Australian frog rankings shows that a sound, threatened species list is much more than the result of moving a marker up and down. A revision of the 1992 NSW lists is in order.

The second conclusion is that the lists have created a group of outcasts, the non-listed species. We call these 'the neglected 74%', yet it is our judgment that not only should they be included in the primary thrust of conserving biodiversity, but they also offer opportunities, such as populations amenable to effective experimental sampling and manipulation, to aid in the process of identifying threats and evaluating solutions that are not possible with threatened species.

Acknowledgements

We are indebted to many colleagues over many years for discussions on this matter and the internal support from the Department of Environment and Conservation (which includes the NSW National Parks and Wildlife Service) to research this matter, to the Council of the Royal Zoological Society of NSW for its support of the forum that created the opportunity to produce this paper, to members of the WWF Frogs! Scientific Panel and to Irina Dunn, Pat Hutchings and two referees for critical comments on the manuscript.

References

ANZECC/BDAC. 2001. *Biodiversity Conservation Research: Australia's Priorities.* Environment Australia, Canberra, ACT.

Barker, J. and Grigg, G. C. 1977. *A Field Guide to Australian Frogs*. Rigby, Adelaide.

Barker, J., Grigg, G. C. and Tyler, M. J. 1995. *A Field Guide to Australian Frogs*. Surrey Beatty & Sons, Chipping Norton, NSW.

Belcher, C. 2004. The largest surviving marsupial carnivore on mainland Australia: the Tiger or Spotted-tailed Quoll *Dasyurus maculatus*, a nationally threatened, forest-dependent species. Pp 612-23 in *Conservation of Australia's Forest Fauna* (second edition), edited by D. Lunney. Royal Zoological Society of NSW, Mosman, NSW.

Christy, M. T. 2003. Making headlines or saving a species? *Australian Zoologist* 324-28, in the proceedings of the *Zoology and the Media* forum, edited by D. Lunney, A. Matthews and P. Wilson. *Australian Zoologist* 32, No 2, 2003.

Cogger, H. G., Cameron, E. E., Sadlier, R. A. and Eggler, P. 1993. *The Action Plan for Australian Reptiles.* ANCA, Canberra.

Cogger, H. G. and Lunney, D. 1992. The *Endangered Fauna (Interim Protection) Act 1991*: criteria for the selection of threatened, vulnerable and rare species of fauna. Pp. 1-9 in *The Endangered Fauna Act in Action,* edited by the Environmental Defender's Office, Sydney.

Commonwealth of Australia. 1992. *National Forest Policy Statement. A new focus for Australia's forests.* (second edition). Australian Government Publishing Service, Canberra.

Dickman, C. R., Lunney, D. and Matthews, A. 2000. Ecological attributes and conservation of native rodents in New South Wales. *Wildlife Research* 27: 347-55.

Donnellan, S. C. and Mahony, M. J. 2004. Allozyme, chromosomal and morphological variability in the *Litoria lesueuri* species group (Anura: Hylidae), including a description of a new species. *Australian Journal of Zoology* 52: 1-28.

Goldingay, R. L. 1996. The green and golden bell frog *Litoria aurea* – from riches to ruins: conservation of a formerly common species. *Australian Zoologist* 30: 248-56.

Greer, A. E. 1996. Why green and golden bell frogs *Litoria aurea* should not be translocated – an unpublished opinion. *Australian Zoologist* 30: 257-8.

Griffiths, T. 2001. One hundred years of environmental crisis. *The Rangeland Journal* 23: 5-14.

Hamilton, C., Lunney, D. and Matthews, A. 2000. An economic evaluation of local government approaches to koala conservation. *Australian Journal of Environmental Management* 7: 158-69.

Jarman, P. J. and Brock, M. A. 2004. The evolving intent and coverage of legislation to protect biodiversity in New South Wales. Pp 1-19 in Threatened Species Legislation: is it just an act? edited by P. Hutchings, D. Lunney and C. Dickman. Royal Zoological Society of NSW, Mosman, NSW.

Knowles, R., Mahony, M., Armstrong, J. and Donnellan, S. 2004. Systematics of sphagnum frogs of the genus *Philoria* (Anura: Myobatrachidae) in eastern Australia, with the description of two new species. *Records of the Australian Museum* 56: 57-74.

Körtner, G., Gresser, S. and Harden, B. 2003. Does fox baiting threaten the spotted-tailed quoll, *Dasyurus maculatus*? *Wildlife Research* 30: 111-8.

Lunney, D. (ed.). 1992. *Zoology in Court*. Royal Zoological Society of New South Wales, Mosman, NSW.

Lunney, D. 1994. Review of official attitudes to western New South Wales 1901-93 with particular reference to the fauna. Pp. 1-26 in *The Future of the Fauna of Western New South Wales,* edited by D. Lunney, S. Hand, P. Reed and D. Butcher. Royal Zoological Society of NSW, Mosman, NSW.

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. *The Rangeland Journal* 23: 44-70.

Lunney, D. and Ayers, D. 1993. The official status of frogs and reptiles in New South Wales. Pp. 404-8 in *Herpetology in Australia: a Diverse Discipline*, edited by D. Lunney and D. Ayers. Royal Zoological Society of NSW, Mosman, NSW.

Lunney, D., Curtin, A., Ayers, D., Cogger, H. G. and Dickman, C. R. 1996. An ecological approach to identifying the endangered fauna of New South Wales. *Pacific Conservation Biology* 2: 212-31.

Lunney, D., Curtin, A. L., Ayers, D., Cogger, H. G., Dickman, C. R., Maitz, W., Law, B. and Fisher, D. 2000. The threatened and non-threatened native vertebrate fauna of New South Wales: status and ecological attributes. *Environmental and Heritage Monograph Series No. 4*. Pp. 1-132. (NSW) National Parks and Wildlife Service, Hurstville.

Lunney, D., Curtin, A., Fisher, D., Ayers, D. and Dickman, C. R. 1997. The ecological attributes of the threatened fauna of New South Wales. *Pacific Conservation Biology* 3: 13-26.

Lunney, D. and Matthews, A. 2004. Conserving the forest mammals of NSW. Pp 988-1021 in *Conservation of Australia's Forest Fauna* (second edition), edited by D. Lunney. Royal Zoological Society of NSW, Mosman, NSW.

Lunney, D., Matthews, A., Stein, J. A. and Lunney, H. W. M. 2003. Australian bat research: the limitations of *The Action Plan for Australian Bats* in determining the direction of research. *Pacific Conservation Biology* 8: 255-60.

Lunney, D., Matthews, A., Moon, C. and Turbill, J. 2002. Achieving fauna conservation on private land: reflections on a ten year project. *Ecological Management and Restoration* 3: 90-6.

Lunney, D., Urquhart, C. A. and Reed, P. (eds). 1990. *Koala Summit. Managing Koalas in NSW*. Proceedings of a conference held at the University of Sydney 7-8 November 1988. Pp. 1-268. (NSW) National Parks and Wildlife Service, Hurstville.

Margules, C. R. and Pressey, R. L. 2000. Systematic conservation planning. *Nature* 405: 243-53.

Millsap, B. A., Gore, J. A., Runde, D. E. and Cerulean, S. I. 1990. Setting the priorities for the conservation of fish and wildlife species in Florida. *Wildlife Monographs Supplement Journal of Wildlife Management* 54: 5-57.

Noble, J. 2001. Guest editorial. *The Rangeland Journal* 23: 3-4.

Pressey, R. L., Whish, G. L., Barrett, T. W. and Watts, M. E. 2002. Effectiveness of protected areas in north-eastern New South Wales: recent trends in six measures. *Biological Conservation* 106: 57-69.

Pyke, G. H. and Osborne, W. S. (eds). 1996. The green and golden bell frog *Litoria aurea*: biology and conservation. Special Edition. *Australian Zoologist* 30.

Pyke, G. H. and White, A. W. 2001. A review of the biology of the green and golden bell frog *Litoria aurea*. *Australian Zoologist* 31: 563-98.

Tyler, M. J. 1997. *The Action Plan for Australian Frogs.* Wildlife Australia, Canberra. 77 pages.

APPENDIX I

The Koala *Phascolarctos cinereus*, shown here wearing a radiotransmitter, is a great icon for the cause of forest dependent fauna, but if threatened species recovery was the only criterion for conserving biodiversity, we would have a warped sense of priorities because we would be neglecting non-threatened species, which constitute most of the fauna.

Photo: D. Lunney.

The Bush Rat *Rattus fuscipes*, shown here inside an "Elliott" live trap, is one of the neglected 74% of vertebrate fauna but it is a valuable species for monitoring impacts because it occurs in sufficient numbers to show changes through time.

Photo: D. Lunney.

The Tusked Frog *Adelotus brevis* was not listed as threatened in 1992 but was ranked second in NSW in a 2003 assessment by the WWF Frogs! Panel using Millsap biological scores. This frog provides one example of how inadequate knowledge has undermined the listing process and why a revision of the 1992 NSW lists is in order.

Photo: D. Lunney.