Turning the spotlight onto the conservation of Australian bats and the extinction of the Christmas Island Pipistrelle[1]

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ABSTRACT

The 2007 forum on the biology and conservation of Australasian bats provided a snapshot of the issues and state of knowledge at that time, now recorded for posterity in this book. As we went to press in 2011, the 'International Year of the Bat' provided an opportunity for bat researchers and managers to publicise some of the pressing conservation issues facing bats. No story exemplifies these more than the recent extinction of the Christmas Island Pipistrelle *Pipistrellus murrayi*. In his reflective book on forest pattern and ecological process, ecologist David Lindenmayer emphasised the complementarity between species-oriented and ecosystem-oriented research approaches. This applies to all of Australasia's bat fauna. The conclusion we draw is that basic research on both individual species and the ecosystems in which they dwell is required to underpin management actions, and that this research must be integrated with community education, sound policy and a commitment to act on research and monitoring outcomes.

Key words: Christmas Island Pipistrelle; Year of the Bat; extinction; endangered species.

Introduction

The papers presented in this book, from the forum in April 2007 organised by the Royal Zoological Society of NSW and the Australasian Bat Society (ABS), provide a record of the conservation issues and state of knowledge of Australasian bats at this time. In this paper we extend the record by exploring conservation issues publicised by the United Nations for the Year of the Bat (2011), and consider one of the most important recent conservation lessons by examining the processes and commentary in the lead-up to the recent extinction of the Christmas Island Pipistrelle *Pipistrellus murrayi*.

The Royal Zoological Society of NSW has held a long-term interest in bats. It hosted the Eighth International Bat Research Conference, and a questionnaire survey of participants revealed a clear need for greatly increased attention to specific areas in bat conservation, and that bat conservation should move into the public spotlight (Lunney 1989). Considerable progress has been made since 1989 and we have become more acutely aware of the costs of inaction. There is now a growing group of people sufficiently skilled to be able to advance the conservation and management of bats in Australasia. This book displays the range of skills needed to study and conserve our bat fauna. We draw attention to the growing body of expertise and urge new bat researchers to both study bats and argue the case for their conservation.

It may be surprising to many readers that there is virtually a complete absence of historical data on the abundance or status of most Australasian bat species, which continues to impinge on the effective management of bats today (Pennay *et al.* 2011). Rigorous study and monitoring of bat species, across a range of environments, is urgently required to help overcome this problem. It is our view that both the national and State lists of threatened species will grow as we awaken, in one generation, from ignorance about bats to awareness of multiple crises.

'Year of the Bat' gives wings to the world's only flying mammals

In late 2010, the United Nations announced that 2011 will be the Year of the Bat. We hope that more than bat biologists, bat rehabilitators and bat conservationists take note of the international recognition of bats. As a first step, we have extracted relevant items from the UN's website to feed into our Australian view.[2] We have used a series of points, given in quotations, so that the language is preserved, as well as the points. The tone matters, as do the key words and phrases, such as "misunderstood and

[1] This paper was drafted to capture the mood, findings and ideas of bat biologists that emerged in the April 2007 forum on the biology and conservation of Australasian bats. It was been updated as the new reports of the Christmas Island Pipistrelle emerged, mentions the Year of the Bat 2011, and our addresses were updated as of July 2011.

[2] http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=647&ArticleID=6757&l=en&t=long, last accessed 2 October 2010

Pp. 485–498 in *The Biology and Conservation of Australasian Bats*, edited by Bradley Law, Peggy Eby, Daniel Lunney and Lindy Lumsden. Royal Zoological Society of NSW, Mosman, NSW, Australia. 2011.

persecuted mammals", "Most people are unaware that bats provide invaluable services to the environment", and "All European bats are to a greater or lesser extent endangered with extinction". Most people are surprised to learn that a quarter of the world's mammal species are bats, and this proportion also applies to Australia. The quotes were selected to demonstrate common ideas, views and struggles.

> Bat populations have declined alarmingly in recent decades. Despite intensified conservation efforts, over half of all bat species are now classified by the International Union for Conservation [of Nature] as threatened or near threatened. Habitat loss and destruction, human disturbance at hibernation sites, increasing urbanisation and epidemics such as White-nose Syndrome – which has killed more than half a million bats in the United States since 2006 – are putting bats increasingly in danger.
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> Bat species throughout the world need continued protection. Most people are unaware that bats provide invaluable services to the environment. Fruit agriculture, central to tropical economies, depends to a large extent on the ecological contributions of fruit bats. An estimated 134 plants that yield products used by humans are partially or entirely reliant on bats for seed dispersal or pollination.
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> "Bats rank among our planet's most misunderstood and intensely persecuted mammals because they are active only at night and difficult to observe and understand", says Dr [Merlin] Tuttle [honorary ambassador for the Year of the Bat]. "Many bats are the primary predators of insects that fly at night, for example, including those that cost farmers and foresters billions of dollars in losses annually. When these bat populations decline, demands for dangerous pesticides grow, as does the cost of growing essential crops like rice, corn and cotton".
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> Environmental experts increasingly regard bats as indicators of biodiversity and healthy ecosystems. With biodiversity as an integral part of the campaign, the Year of the Bat will encourage people across the world to get involved in bat conservation efforts, so that these fascinating 'masters of the night sky' can continue to delight us and perform their invaluable services to the global environment.

The Year of the Bat for Australia

The international focus on bats by the UN is most welcome indeed because it throws a spotlight on all bats. What we learn in Australia can contribute to the international effort to conserve bats and bat habitats. Similarly, the world effort can contribute to Australia's effort to conserve our bat fauna. Consider EUROBATS, with the following quote taken from An Introduction to EUROBATS and the Bat Agreement:[3]

> The Agreement on the Conservation of Populations of European Bats [EUROBATS], which came into force in 1994, presently numbers thirty European states among its Parties, from North, South, East and West. The Bat Agreement aims to protect all 45 species of bats identified in Europe, through legislation, education, conservation measures and international co-operation with Agreement members and with those who have not yet joined. The most significant items ... are monitoring and international activities. A pan-European observation study is to identify population trends and then to facilitate the timely introduction of measures to address any problems which the study's results might throw up. The study is based upon representative species, and consistent methods for observing them are to be used.

The section on bat conservation is simple, but clear:

> **Threats to Bats' Survival.** All European bats are to a greater or lesser extent endangered with extinction. Some have even become extinct in certain countries. The reasons for this are mainly: loss of roosts; loss of feeding areas and increased use of pesticides, both in agriculture and in the protection of building materials against pest action, which in turn poison the bats who consume them; misunderstanding and prejudice arising from ignorance about bats and their lives and habits.[4]

What emerges from the account of EUROBATS is that the problems are familiar indeed to those who study or manage bats in Australia, but since Australia has about twice as many bat species as Europe, the issues are more varied. We urge all those readers interested in bat conservation to give more thought to, and to support more action for, bat research, management and education. To make that point vividly, we examine the case of the extinction of the Christmas Island Pipistrelle.

The case of the Christmas Island Pipistrelle

The rapid decline of the Christmas Island Pipistrelle

The Christmas Island Pipistrelle highlights the problems associated with monitoring the decline of a species without identifying the key causes and addressing the issues in a timely manner. The story of the decline of the Christmas Island Pipistrelle was recounted by Lindy Lumsden in January 2009 under the unambiguous heading: "The Christmas Island Pipistrelle (*Pipistrellus murrayi*) at risk of extinction within six months!".[5]

> The Christmas Island Pipistrelle, at just 3 g, is one of Australia's smallest bats, and almost certainly the rarest. It is endemic to Christmas Island, a tiny island in the Indian Ocean just 135 km^2 in size, and is the only species of microbat present. Its distribution and

3 http://www.eurobats.org/about/about_EUROBATS.htm, last accessed 2 October 2010

4 http://www.eurobats.org/about/about_bat_conservation.htm, last accessed 2 October 2010

5 http://batcall.csu.edu.au/abs/ChristmasIsland/PipistrellusmurrayiJan_09.htm, last accessed 3.10.10

numbers have declined dramatically in recent years and, as a result it was listed in 2006 as 'Critically Endangered' under the national *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. Surveys undertaken in the mid-1980s found it to be common and widespread across the island (Tidemann 1985). By the mid-1990s there had been a marked reduction in numbers and a westward range contraction (Lumsden and Cherry 1997; Lumsden *et al*. 1999). The species is now confined to the far west of the island, no longer occurring across most of its former range (James and Retallick 2007; Lumsden *et al*. 2007). Long-term monitoring using ultrasonic bat detectors indicates this species has undergone a 99% decline in relative abundance since 1994 (James and Retallick 2007; Lumsden *et al.* 2007; Parks Australia North Christmas Island unpublished data).

A reassessment of the number of individuals remaining in January 2009 suggested there could be as few as 20 individuals left. The only known communal roost contained only four individuals. Three years ago there were 54 individuals in this colony and there were several other known, similar-sized colonies. The long-term monitoring data and the recent reassessment suggest that, if the current rate of decline continues, this species is likely to be extinct within the next 6 months! (Figure 1). The cause of this rapid decline remains unknown, despite the identification of a range of potential threatening processes (Schulz and Lumsden 2004; James 2005; James and Retallick 2007; Lumsden *et al*. 2007). Extensive areas of habitat are available, with 75% of the island covered by primary or secondary rainforest. The pipistrelle is a generalist aerial insectivore and as there appears to be an abundance of nocturnal flying insects, lack of food is unlikely to be the cause. Predation or disturbance at roost sites is considered one of the most likely threats to the survival of the species (Schulz and Lumsden 2004; Lumsden *et al*. 2007). Individuals roost in colonies under exfoliating bark on dead trees, many of which are heavily decayed and collapsing (James and Retallick 2007; Lumsden *et al*. 2007). A number of introduced species may be preying on, or disturbing, bats from within their roosts, including Common Wolf Snake *Lycodon aulicus capucinus*, Black Rat *Rattus rattus*, Feral Cat *Felis catus* and Giant Centipede *Scolapendra morsitans*. Although not considered the primary cause of decline, the recent explosion of Yellow Crazy Ants *Anoplolepis gracilipes* is likely to have exacerbated the situation.

A range of management actions are currently being undertaken to monitor the population and control some threatening processes, including installing protective barriers around the base of known roost trees, extensive detector surveys to locate foraging areas and searches for potential roost sites. However, despite these efforts the population continues to plummet to a critically low level.

It is critical therefore that a captive breeding program is established immediately as insurance against further decline in numbers and as a source of individuals to re-establish wild populations once the cause of decline has been identified and controlled (James and Retallick 2007; Lumsden *et al*. 2007).

While the article drew attention to the urgent need for immediate action, knowledge of the rapid decline and predicted imminent extinction of the species was not new. There had been at least seven reports written since the mid-1990s highlighting the decline of the species (Lumsden and Cherry 1997; Lumsden *et al*. 1999; James 2005; Corbett *et al*. 2003; James and Retallick 2007; Lumsden *et al*. 2007; Lumsden and Schulz 2009) and this information was available on the Australian

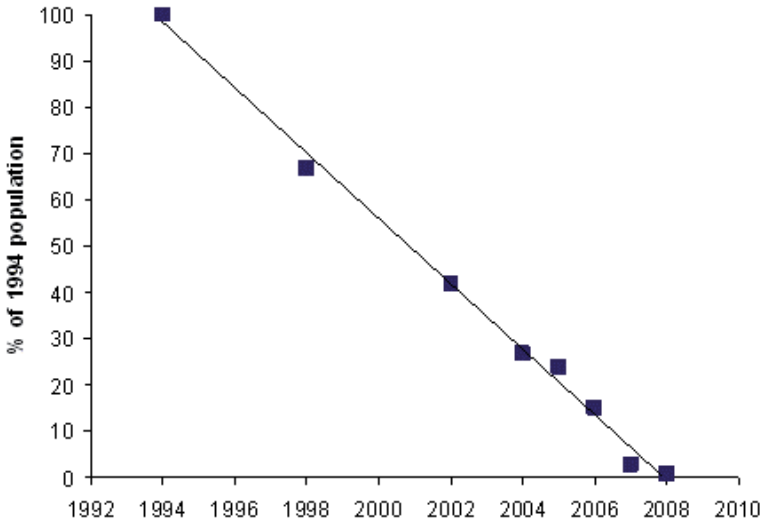

Figure 1. Decline of the Christmas Island Pipistrelle. This record was based on repeated sampling using bat detectors at set sites across the Island up to 2006. Since 2006, the detector monitoring focussed just on the west of the Island where the species still occurred. The 2007 and 2008 figures are based on the relationship between these data and that of 2006 at these same sites, to make this as comparable as possible. This identifies that the species had declined by 99% since 1994 and that the species could go extinct in 2008/09. (Figure reproduced from Lumsden and Schulz 2009.)

Commonwealth Environment Department website (DSEWPC 2011). The graph that predicted the extinction of the species in 2008/09 (Figure 1) was first developed in 2006 (Lumsden *et al*. 2007). The Threatened Species Scientific Committee had advised the then Minister for the Environment and Heritage that the species was eligible for listing as Critically Endangered under the EPBC Act in 2006. A National Recovery Plan had been prepared in 2004 (Schulz and Lumsden 2004).

By March 2007, the known population was at least 167 individuals, but was estimated to be between 500 and 1000 bats. With the cause of the decline still unknown, a report to the Commonwealth Environment Department (Lumsden *et al*. 2007) recommended that a captive population be established as the highest priority: "Such a colony would provide insurance against further decline in numbers, and a source of animals to re-establish wild populations once the cause of the decline has been identified and controlled.

Although the Christmas Island Pipistrelle had not previously been kept in captivity, many other species of small insectivorous bats have been, including other species of pipistrelles (e.g. Kleiman 1969, Eales *et al*. 1988, Dondini and Vergari 1995, Kelly *et al*. 2008). There was extensive experience on the captive care and husbandry of bats that could be used to guide the Christmas Island Pipistrelle captive breeding program (e.g. Lollar and Schmidt-French 1998, Jackson 2003, Lumsden and Schulz 2009).

Response from the Commonwealth government

In February 2009, following the January monitoring which suggested the population was as low as 20 individuals, the Government established the Christmas Island Expert Working Group (EWG). While initially just focussing on the Christmas Island Pipistrelle, the working group's brief expanded to examine all threats to the Island's ecology and biodiversity management (Beeton 2010; Beeton *et al*. 2010).

Advice to the Minister for Environment and Heritage, from the Threatened Species Scientific Committee on Amendments to the list of Threatened Species under the EPBC Act, judged the Christmas Island Pipistrelle to be eligible for listing as Critically Endangered under Criteria 1 and 2 (reduction in numbers and geographic distribution), Endangered under Criterion 3 (limited and declining numbers), and having insufficient quantitative data to make assessments under Criteria 4 and 5 (low numbers, and probability of extinction in the wild).[6] The Committee therefore judged the species, in 2006, to be eligible for listing as Critically Endangered under the EPBC Act.

Media publicity

The issue attained public prominence in February 2009, well after its listing as Critically Endangered. The Pipistrelle featured in a range of radio, print and electronic media. Following are two examples of newspaper articles produced at this time. They are selected here because the print media lends itself more readily to historical study.

> a) "Garrett goes in to bat for species on sticky wicket". Nick Galvin, *Sydney Morning Herald, 16 February, 2009:*
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> For 14 years the plight of the tiny Christmas Island pipistrelle bat appears to have escaped the attention of politicians. But now, with fewer than 20 of the creatures remaining and faced with the unwelcome prospect of the first Australian mammal in more than 50 years becoming extinct on his watch, the Environment Minister, Peter Garrett, has finally acted. He said the Threatened Species Scientific Committee had confirmed extinction of the bat, which weighs less than an empty matchbox, was almost inevitable. "Unfortunately [the committee] also advised me that there is a high risk associated with a proposed captive breeding program" he said. "The bats are also very difficult to catch and no one knows how to keep them alive for breeding. We will do whatever is practical and feasible to save the pipistrelle. I am deeply concerned by the fact its prospects do not appear bright on the basis of our current understanding of the situation"."
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> b) "Garrett rejects move to save endangered bat". Peter Ker, *The Age*, 16 February 2009.
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> Australia is almost certain to lose a mammal to extinction for the first time in 53 years, Environment Minister Peter Garrett says. Mr Garrett said the rare Christmas Island pipistrelle bat's tiny population was a reason not to embark on a captive breeding program. The decision prompted concerns from bat experts that the Federal Government was giving up on the species too easily, with warnings that the species could be extinct within four months. Mr Garrett responded pessimistically to a committee of threatened species experts. "The committee has confirmed what we feared; the pipistrelle is in severe decline and extinction in the wild is almost inevitable" he said. Some experts believe that could be too late. Bat expert Dr Greg Richards said that given the grim forecasts for the pipistrelle population, an immediate captive breeding program would have been worth the risk. "There are examples of microbats being kept in captivity and breeding successfully, so I think the committee has probably needed to do some extensive research" he said. If it becomes extinct, the pipistrelle will be the first mammal lost in Australia since a strain of wallaby died out in 1956."

Parliamentary scrutiny

The issue also received attention in the federal parliament. In a speech to the House of Representatives, the MP for Farrer, Sussan Ley, raised the matter. Excerpts from the speech (on Thursday, 19 March 2009, 12.19 pm) are from Hansard.

> Christmas Island Pipistrelle. I want to talk about the imminent extinction of a critically endangered animal species – that is, the Christmas Island pipistrelle, which is one of Australia's smallest bats. If we allow this small mammal to become extinct, it will be the

[6] (http://www.environment.gov.au/biodiversity/threatened/species/pubs/pipistrellus-murrayi-listing.pdf, no date given, last accessed 3 October 2010)

first mammal extinction in Australia for about 50 years. I have been contacted by a zoologist in the west of my electorate, Mr David Gee, who is part of a network, including the Australasian Bat Society and other conservationist and wildlife biologists, who are incredibly concerned about this. What the Australasian Bat Society is proposing is a three-stage program: an emergency rescue program aimed at catching the few remaining animals and establishing a captive colony; if sufficient individuals are caught and they survive being taken into captivity, a long-term captive breeding program in a purpose-built facility on Christmas Island with experienced staff to run it, which would need to be maintained for 10 years; and targeted research to determine the cause of the decline so that mitigation actions can be undertaken. If – and I agree with my constituent David Gee that it is a big if – a captive population can be established, it will buy time so that the environmental attributes that are causing the extinction can be identified and hopefully corrected so that captive-bred individuals can be released back on Christmas Island in order to re-establish a wild population. This is a tiny mammal which weighs less than three grams. In the big picture, people may say, "Who cares?" But we should care, because when a species becomes extinct there is no going back and, if action can be taken to prevent it, we would all be better human beings for having taken it.

Extinction

The Commonwealth Environment Minister, representatives from Parks Australia, and the Threatened Species Scientific Committee, met with the ABS in May 2009 and discussed the proposal to establish a captive breeding population. Permission was given in July 2009 for an emergency rescue attempt, but it was too late. The ABS and Zoos Victoria rescue team arrived in August, with a summary of the rescue attempt provided in Lumsden (2009). Initially, extensive detector surveys were undertaken, building on the long-term monitoring undertaken by the Christmas Island National Park staff, to locate where remaining individuals were roosting and foraging. It soon became apparent that only one individual remained. Before it could be caught, it too disappeared. The last night a Christmas Island Pipistrelle was heard or seen was on 26 August 2009. As the only species of insectivorous bat on the island, sampling using bat detectors had been very effective. Detector monitoring has continued by Christmas Island National Park staff, but there has been no further evidence of the species. It appears that the species did go extinct on 26 August 2009 (Lumsden 2009). There have been no records of the species since.

The findings of the Christmas Island Expert Working Group

The relationship between focusing conservation efforts on individual species or trying to understand and manage whole ecosystems was spelled out in the Christmas Island Expert Working Group's final report to the Minister for the Environment (Beeton *et al*. 2010).[7] Extracts from their report illustrate the issues.

The Island has extraordinary terrestrial, subterranean and marine conservation values that are being diminished by management deficiencies and threats that are pervasive, chronic and increasing. Unfortunately, these problems will not have simple solutions. Christmas Island has already suffered two confirmed extinctions (two native rodent species *Rattus macleari* and *R. nativitatis*), and two probable extinctions, the Christmas Island Pipistrelle (*Pipistrellus murrayi*) and the Christmas Island Shrew *(Crocidura trichura*). Furthermore, the Island is currently witnessing further rapid declines in other important species. At risk of extinction in the short to medium term are its few remaining endemic reptile species, some of its endemic birds and, quite possibly, a fifth mammal, the Christmas Island Flying Fox (*Pteropus natalis)* which is the only remaining indigenous mammal on the island. It is also probable that seven plant species and several invertebrate species are extinct.

We warn that a "business as usual" approach in future will mean that management will fail and the extraordinary national asset that is Christmas Island's biodiversity will be replaced by a combination of many introduced and a few resilient native species." "Recognition of the parlous decline of the Christmas Island Pipistrelle was the catalyst for this inquiry, particularly the report by Lumsden (Lumsden and Schulz 2009). The fate of the Christmas Island Pipistrelle was likely collateral damage associated with the broad-scale environmental changes triggered by the deliberate or – in most cases – inadvertent introduction of non-indigenous species to Christmas Island. Oceanic islands may be particularly susceptible to such perturbation, and Christmas Island has provided a text book example of "invasional meltdown" (O'Dowd *et al.* 2003), the collapse of existing ecological processes and structure, and of inter-specific relationships, because of the impacts of one or more invasive species.

For the Christmas Island Pipistrelle, actions over the last 12 months have been too little too late and have failed to save it from extinction, an outcome that is deeply regrettable. Its extinction was predicted several years earlier, and options for its survival were largely foreclosed soon after. Its loss is now a lesson and the EWG has sought in this report to identify changes that must be made to ensure that other extinctions will not follow.

The lesson to be learnt is that the early recognition of the rapid change in the Island's ecological function in the mid-1990s (Lumsden and Cherry 1997; O'Dowd *et al.* 2003) should have initiated an urgent and comprehensive review followed by management actions. Instead, piecemeal responses that occurred demonstrate that management without sound science-based monitoring and sound scientific interpretation that is acted on will fail.

7 http://www.environment.gov.au/parks/publications/christmas/pubs/final-report.pdf, last accessed 4 October 2010

Individual species become the issue

The case of the Christmas Island Pipistrelle appears to have prompted a shift in government conservation policy. In the *Sydney Morning Herald* of 21 September 2009, under the headline "Peter Garrett on Biodiversity", the article by Tom Arup opens with the statement:

> Why the Environment Minister believes we can no longer simply focus on saving individual species. Last month Garrett gave a speech to a conference of ecologists telling them with the resources he had he would be better served protecting ecosystems rather than focusing money on single species. Mr Garrett added that there should also be a recognition that it may be too late to save some species from extinction and resources would be better spent strengthening the wider ecosystem the animal lives in.

Below are extracts from an interview Tom Arup conducted with minister Garrett.[8]

> ***Tom Arup:*** Last month you talked about the imperative of saving ecological communities as opposed to addressing issues on a single species basis. What has led you to think about biodiversity and conservation in this manner?
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> ***Minister Garrett:*** I think that it is increasingly evident that the approaches of the past haven't succeeded sufficiently to halt the decline in biodiversity generally, and specifically to remove immediate threats to our really unique endemic native plant and animal species. And because we are now facing significant additional threats by way of climate change impact it's very clear to me that a much more holistic approach is needed.
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> ***Tom Arup:*** In the speech you referred to the Christmas Island pipistrelle and the advice you got from the Threatened Species Scientific Committee that there was no realistic chance of this species surviving and money should instead go to the wider ecosystem? In the speech you said having limited resources you had a lot of sympathy for this argument. Is that an admission an Environment Minister cannot protect every species from extinction?
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> ***Minister Garrett:*** Well I think the environment minister must do everything possible to enable that protection. But in this case I'm mindful that if we are looking at how we maximise protection for each of those individual species, it is very clear and the advice from that expert group in relation to the (Christmas Island) pipistrelle was clear – that you may have a situation where no matter how much effort you apply in the short-term you still are faced with the terrible prospect of not succeeding in saving a species." "I think the other thing is that this is about insuring that we actually have biodiversity at the top of the agenda not just a species which for all very good reasons captures our attention.
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> ***Tom Arup:*** Ecologists are consistently saying there is a crisis in biodiversity on the same scale and needing the same level of action as climate change? Do you agree the biodiversity crisis is comparable to climate change, and has global warming overshadowed the biodiversity crisis?
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> ***Minister Garrett:*** Well I think from the point of view of a conservation biologist of course I understand they would like to see this issue profiled consistently, continually. And it's certainly something I'm very committed to doing but at the same time I think whatever area you are looking at, whether it is energy or coastal planning, wet lands management or biodiversity more generally, climate change is the shadow that looms large.

"A bucket of cash"

Our account of the loss of the pipistrelle now changes tack from the political to the views from the hard-hitting newsletter/journal of *Decision Point*, a leading ecological think tank, because we are concerned that the point of the extinction of this bat may have been lost. In *Decision Point* #43 – 2 September 2010, David Salt (as editor of *Decision Point* [http://www.aeda.edu.au/news]) has a strong viewpoint that touched on the pipistrelle matter.[9]

> "The news is not good," says the Executive Secretary of the Convention on Biological Diversity in a press release announcing the findings of the GBO-3, i.e. Global Biodiversity Outlook.[10] "We continue to lose biodiversity at a rate never before seen in history – extinction rates may be up to 1,000 times higher than the historical background rate." We'll throw a bucket of cash on to a crisis situation like the vanishing (vanished?) microbats of Christmas Island rather than consider what other interventions we might take to prevent other species from getting to this point. This little dummy spit was prompted by a talk I've been preparing on the state of our biodiversity for the Australian Festival of Science in Canberra."

While David Salt makes a good point about the need for early intervention to prevent other species from declining to critically low levels, it appears that he was under the impression that 'a bucket of cash' was thrown at the Christmas Island Pipistrelle in an attempt to prevent its extinction. Unfortunately this was not the case. Had sufficient money been spent early enough, the species may have been saved from extinction. While there had been extensive monitoring of the decline of the species, little funding was provided, over the 15 years of this decline, to investigate its cause. Even at the death knell, when the emergency rescue was finally allowed to proceed, the ABS members on the team were required to go as volunteers to keep the costs down for the government.

8 http://www.smh.com.au/opinion/blogs/greenlines/peter-garrett-on-biodiveristy/20090921-fyhv.html, last accessed 4.10.10

9 http://www.aeda.edu.au/docs/Newsletters/DPoint_43.pdf#view=Fit&pagemode=bookmarks&page=2; last accessed 4 October 2010

10 http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=624&ArticleID=6558&l=en&t=long

Our interpretation of the sequence of events

The story of the extinction of the Christmas Island Pipistrelle has flushed out some of the fundamental problems in conserving biodiversity in Australia. If we are ignorant of such a large group of animals as bats, then it follows that we shall be slow to respond to all the issues in conservation because we cannot clearly see the problem when one species is in strife.

At the time the issue was raised by the member for Farrer in March 2009, the Christmas Island Pipistrelle was functionally extinct, as reported by the EWG to the minister in April 2009 in their interim report (Beeton *et al*. 2009). The member for Farrer was taking the minister to task for dithering in the face of a crisis. However, a different view was taken by Tim Flannery (*Sydney Morning Herald,* 28 July 2010), namely that this extinction was a tragedy, not just a question of tardiness. The expert working group reported in 2009 that it was the Lumsden (2009) report on the Christmas Island Pipistrelle that triggered their investigation of the wider issues of the decline in the biodiversity of Christmas Island (Beeton *et al*. 2010). The comments by the EWG were biting, and their conclusion vindicated the concerns in the reports of decline of the Christmas Island Pipistrelle. Their wording was striking:

> The Christmas Island Pipistrelle is effectively a case study in extinction. Reflecting rapid and permanent loss of recovery options between the Interim Report and this report, those recommendations are now redundant, and this consideration shifts from one of prospective management to retrospective analysis, or inquest.

The limitations on the Commonwealth's approach to bats have been the subject of critical comment before, in the narrow focus of its Bat Action Plan (Lunney *et al.* 2003), but now the comments can be expanded. We consider that bat conservation requires a thorough working knowledge of a wide range of species, not just those listed on any particular threatened species act. We also consider that threatening processes should be examined, such as loss of hollow-bearing trees, and not just for those species that are listed as threatened. Such a focus also needs to be considered in the context of ecosystems. This can be achieved by assessing information about the habitats in which individual species feed and roost, and how the ecosystem is faring if it is under threat, whether that be an island, a logged forest, or an urban restoration scheme. The key point is that the species and ecosystems approach are complementary for achieving better conservation outcomes.

Conclusions

In his thoughtful and reflective book on forest pattern and ecological process, David Lindenmayer (2009, p 268) emphasised the complementarity between species-oriented and ecosystem-oriented research approaches. His study of a single species (Leadbeater's possum *Gymnobelideus leadbeateri*) has expanded to include the habitat of other species and ecosystem-oriented investigations of disturbance regimes, such as wildfire and logging, and how they affect stand structural complexity, landscape heterogeneity and the long-term dynamics of critical forest structures. The other point that Lindenmayer makes (p 254) is the urgent need for monitoring to provide the signal for when we should act. The intriguing thing for the pipistrelle is that this information was available, but action was still not taken, or at least not fast enough. This provides another example of the protracted arguments about what to monitor, which is Lindenmayer's opening concern in the critical matter of monitoring. Bats need their profile to be raised. We hear all too often that scientists spend too much time buried in their speciality. We agree with those who say there is a need for scientists to speak up. There are numerous, non-confrontational means of doing so, and we urge fellow scientists to adopt them. This was the approach taken in the Christmas Island Pipistrelle case – the scientists working with government to provide the best possible advice based on the current state of knowledge. We also urge policy writers to work with scientists, including bat specialists. This leads to a more important point, namely that of education.

A greater effort is needed to include bats in education programs to raise their profile. This is an important theme that has been addressed in only a small way in this book and we stress it strongly here in this final paper. Elements of existing environmental education programs could be re-focused to include bats. Among our challenges for bat conservation is for enterprising teachers and education officers, in collaboration with bat biologists, to generate exciting bat education programs, or include bats as illustrations of the various issues facing the world, and Australasia in particular.

In Australasia more broadly, we still have a long way to go if we want to ensure no other bat species go extinct. The conclusion we draw is that basic research is required to underpin management actions, but that this must be integrated with effective community education, sound policy and a commitment to act on research and monitoring outcomes. The Year of the Bat has given these matters the much-needed prominence they deserve. Bats are wonderful animals to study, to talk about and to write about, and editing this book and reflecting on all the ideas, and the diversity of the bats, has made the writing of this closing paper a rewarding duty and an illuminating endeavour.

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Appendix.

Photos of the Christmas Island Pipistrelle, the Island and the research

Christmas Island Pipistrelle *Pipistrellus murrayi*. Photos by Lindy Lumsden.

The attempt to trap the last Christmas Island Pipistrelle. Photo by Martin Schulz.

Bat detector set-up on Christmas Island. Photo by Martin Schulz.

Christmas Island is a remote and beautiful place. Photo by Martin Schulz.

Christmas Island Pipistrelle maternity roost. Photo by Martin Schulz.

Christmas Island Pipistrelle with radiotransmitter attached. Photo by Martin Schulz.

Harp traps set on Winifred Beach. Photo by Martin Schulz.

Martin Schulz searching for radiotagged Christmas Island Pipistrelles. Photo by Martin Schulz.

Phosphate-mined landscape on Christmas Island. Photo by Martin Schulz.

Primary plateau rainforest, Christmas Island. Photo by Martin Schulz.