The Priorities Action Statement (PAS) for the threatened bats of New South Wales*

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ABSTRACT

The conservation of NSW bat species is examined within the framework of the procedure for threatened species recovery, Priorities Action Statements (PAS), introduced in 2005 by the NSW government to replace the previous requirement to prepare recovery plans. One of the merits of the PAS initiative is that it has produced a single statement of the parlous position of bats in NSW, the actions needed to reverse the threats, and a statement of where the priorities lie for action. To assist with that aim, this paper has recorded all 361 actions for the 20 bat species listed as threatened, as well as analyses and comments on that dataset. The PAS process, and the 361 individual recovery actions that comprise the PAS for bats, are described and discussed within the context of current knowledge, so that bat biologists, managers and policy makers can see the scale and emphases of the recovery process for bats. Research and habitat management are the dominant themes in recovery actions for bats. Research actions comprise 163 (45%) of the 361 actions, and the 89 habitat management actions comprise 25% of all bat recovery actions. The primary message from the PAS process is that it has been possible to arrive at a set of actions to provide a basis for management, both at a funding level and a field level, for which research is an integral part. The PAS for bats represents the first official DECCW statement of recovery actions required for all bat species listed as threatened. It provides an indication of the scale and magnitude of threats confronting the bat fauna of NSW. Their future will depend upon the extent to which the PAS for bats is acknowledged, acted upon, and the time and resources given to bat biologists to implement identified recovery actions.

Key words: Priorities Action Statement, flying-fox, bat, recovery plan, conservation assessment, research, habitat management, monitoring, forestry, NSW *Threatened Species Conservation Act 1995*, threatened species.

Introduction

The debate about the management of threatened species will continue for as long as threatened species exist, and the role of any legislative prescription and its implementation will continue to be the subject of fierce discussion. The Royal Zoological Society of NSW has tackled the question of whether threatened species legislation is just an Act (Hutchings *et al.* 2004), and some biologists have become concerned that the clout of the *Threatened Species Conservation Act* 1995 is fading in NSW (Milledge 2007). Our concern here is with how bats are addressed in a framework, known as Priorities Action Statements (PAS), which was initiated following amendments in 2004 to the NSW *Threatened Species Conservation Act* 1995 (TSC Act).

A central tenet of the TSC Act, when it was enacted in 1995, was that it required the preparation and ministerial approval of a recovery plan for every species listed as threatened in NSW, i.e. those species on the schedules of threatened species, endangered populations and ecological communities. During the decade following initiation of the TSC Act in 1995, some 80 plans had been prepared, but their rate of preparation had not kept pace with the scale of the problem. The NSW Scientific Committee, formed under the TSC Act, had, by 2006, over 840 species, 35 populations and 75 ecological communities listed on their schedules (DEC 2006). The NSW government concluded that there was a need to find a new approach to identifying and assigning priorities to the actions needed to recover threatened species, as well as to fast-track their integration into the strategic plans of land management and planning agencies in NSW.

In 2004, the NSW TSC Act was amended to (DECC 2007)

> ... better integrate threatened species with rural and urban land use planning and natural resource management, and with improvements to the development assessment process.

As part of this process, the Director-General of DECC was required to prepare and adopt a NSW threatened species Priorities Action Statement (PAS) for all fauna and flora listed as threatened, that (DECC 2007):

- sets out the recovery and threat abatement strategies to be adopted for each threatened species
- establishes relative priorities and actions to implement the above strategies
- establishes performance indicators to report achievements in implementing recovery and threat abatement strategies and their effectiveness
- contains a status report on each threatened species (where information is available)

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- sets out clear timetables for recovery and threat abatement planning and achievement. (DECC 2007)

The PAS also allows for threatened species and communities with like needs to be grouped. It aims to identify threatened species, populations and ecological communities for which a single species, multi-species, multi-community or regional recovery plan is the most suitable response. Extracts from DECC documentation relating to the PAS, showing the exact wording and the policy context, are given in Appendix 1. We include this and other appendices to provide a permanent record for posterity, given the ephemeral nature of web-based documentation.

We have adopted the vernacular names used on the DECCW web site, except for the Greater Long-eared Bat (south-eastern form) *Nyctophilus timoriensis*, which is now named as Corben's Long-eared Bat *Nyctophilus corbeni* (Parnaby 2009). The Hairy-nosed Freetail Bat, previously referred to as *Mormopterus* species 6, is now named as *Mormopterus eleryi* (Reardon *et al.* 2008).

Of the 39 bat species found in NSW, 21 were listed in 2007 as threatened under the TSC Act, 17 microchiropterans and 4 megachiropterans (Lunney *et al*. 2000; Eby and Lunney 2002). One bat species, the Black Flying-fox *Pteropus alecto*, was removed from the schedules of threatened species in 2008 by the Scientific Committee set up under the TSC Act. Thus the number of threatened bat species stands at 20 as of May 2010. There is a dearth of information available to guide management and recovery of these species. There are no recovery plans for any threatened microchiropterans. A management document was prepared covering the three NSW *Pteropus* species (Eby 1995), only one of which (the Black Flying-fox) was listed as threatened in NSW at the time. More recently, a Recovery Plan under the federal *Environment Protection and Biodiversity Conservation Act* 1999 has been drafted for Grey-headed Flying-foxes *P. poliocephalus* (Eby 2006), which was listed as threatened federally in 2001, and then became the subject of intense local debate on its management (Eby and Lunney 2002). Once approved, the draft federal recovery plan forms the basis of a draft NSW recovery plan for this species.

A National Bat Action Plan was produced by the Federal Government (Duncan *et al*. 1999), although so few species from NSW were listed as priorities for action that Lunney *et al.* (2003) were scathing in their criticism of this federal approach. In particular, it did not address threats in a way that made them eligible for federal funding, making the process more hollow than intended. State legislation, in contrast, had taken a much less exclusive and more local approach (Lunney *et al.* 2000) which allowed far more issues to be examined and acknowledged that local scarcity was important. The question of the best approach to conserving bats has been the subject of concern and discussion among bat biologists for decades, and was expressed in a number of reviews (Lunney 1989; Lunney *et al.* 1996, 2003), and publications by a number of Australia's experienced bat biologists (Hall 1990; Woodside 1990; Richards 1990; Richards and Hall 1996; Law 1996). A number of themes can be discerned from these publications, and high among them is the need for research and, perhaps because it is a readily identifiable threat, the need to protect roosts, be they caves or tree hollows.

The primary aim of this paper is to present an overview and a detailed statement of the Threatened Species Priorities Action Statements (PAS) for bats in NSW as shown by the PAS process during 2006–2007, in which we were active participants. Our role was to work as an expert group to prepare the PAS for bats and submit it for review and processing by DECCW staff. Thus this paper reflects the outcomes of our preparation of the PAS and its subsequent modification and formal adoption by DECCW. Our objective here is to describe the process from our expert working group decisions to their final posting on the web as the official DECCW position. To clarify the process, we have collated the identified actions, and expanded upon examples of the priority recovery actions (which are brief) to place them in the context of research and background knowledge so that bat biologists, managers and policy makers can see the scale and emphases of recent NSW state legislation for conserving the threatened bat fauna of NSW.

The PAS process

The 2004 amendments to the *Threatened Species Conservation Act* 1995 required the then Department of Environment and Climate Change (DECC, now DECCW) NSW to prepare and adopt a PAS that set out the recovery and threat abatement strategies to be adopted for each species and to rank the priorities and actions to implement the above strategies. The PAS was required to be prepared twelve months following the introduction of the amended threatened species legislation.

The objectives of the PAS (DEC 2006) were to:

- move as many species as possible from threatened to non-threatened status
- reduce impacts of Key Threatening Processes as listed by the NSW Scientific Committee
- provide a strategic approach to threatened species recovery, by making strategies and priority actions in the PAS readily available
- involve the community, managers and decision makers at all levels, in working together to implement PAS actions.

The Priorities Action Statement (PAS) for each threatened species consists of a series of *recovery actions*, typically comprised of a one-sentence statement. The priority of each of the recovery actions applies to the State as a whole, but the priority of a given action at a specific location is determined by the relevant land manager. Consequently, the priority of an action could vary across the range of a species within NSW, depending on the decisions of the land manager. For example, the threat of land clearing to a species could be high on private land in a Catchment Management Authority (CMA) or Local Government Area (LGA), but a low priority on public land estate in that area.

Currently (May 2010) there are over 12,000 individual PAS actions for plant and animals species. There are 361

PAS actions for the 20 threatened bat species. Other mammal groups include: marsupials, 359 actions for 24 species; rodents, 113 actions for 11 species, and marine mammals, 32 actions for 7 species.

Each recovery action for a species is associated with a *recovery strategy.* PAS recovery strategies are defined as the guiding generic tools on which to base more detailed actions for species recovery. In 2007, there were 34 standard Recovery Strategies identified in the PAS (DECC 2007) which were designed to assist species recovery, and Threat Abatement Strategies, which deal with minimising each of the Key Threatening Processes determined by the Scientific Committee. Several priority actions are associated with each recovery strategy. Examples of recovery strategies that are common to many bat species include survey, research, monitoring, habitat protection and community and landholder liaison. These strategies are combined with more detailed actions and are assigned a priority ranking in terms of their contribution to achieving recovery for a species. Consequently, each priority action for a species is not designed to operate in isolation. Although 34 standard recovery strategies were identified in the PAS in 2007, fewer strategies were recognised at the time the draft PAS for bats was prepared by the expert workshop in 2006. For example, the recovery strategies of "Diseases and pathogens","Habitat management: grazing" and "Developing and implementing protocols and guidelines" were not considered by the workshop.

Recovery actions, i.e., PAS actions, are ranked in priority by one of three categories as defined by DEC (2006) and DECC (2007):

- High – critical actions that require urgent implementation, without which an eventual decline in status will occur. Can provide essential information on distribution, threats, or conservation status of a threatened species – information that is often an essential precursor to the design and implementation of other management actions;
- Medium – will make an important contribution, though less urgent than high priority;
- Low – will be a valuable addition which is desirable, but not essential.

Each recovery action was assigned to one of the above three priorities by DECCW staff in consultation with specialists.

Individual species were not prioritised during the current PAS process, just the actions. Many threatened bats have a broad distribution across many land tenures and the type and degree of threat will vary across the landscape. Therefore, prioritisation of species at the state wide level was not considered practical. Instead, the priority of recovery actions within species was to be determined at the geographic scale of the relevant land management authority, e.g. Bollard (2008) for the Lachlan CMA and Christian (2009) for the Namoi CMA.

Actions for threatened species can occur across the landscape over many land tenures. To help communicate an action's location, three sorts of 'geographic areas' were identified for the purpose of this PAS. These are CMAs, LGAs and land managed by DECCW, i.e. national parks and nature reserves. These provide both a geographic and land management context for the location of the actions. CMA, LGA and DECCW area boundaries overlap in distribution across NSW. Land administered by Forests NSW for forest products, i.e. State Forests, is not yet covered by the PAS process.

Documentation and Public participation

Public participation involved a two-step process. A draft PAS document was placed on display for public comment from 12 May to 18 August 2006. It listed the proposed recovery actions for most of the 830 plant and animal species listed as threatened, including three bat species: the two Vulnerable species, the Grey-headed Flying-fox, Black Flying-fox, and the Endangered Hairy-nosed Freetail Bat. PAS actions for the two flying-fox species were derived from the draft recovery plan for the Grey-headed Flying-fox, while those of the Hairy-nosed Free-tailed Bat were devised in consultation with DECCW staff. This document was posted on the DEC threatened species website (accessed 1 March 2008, weblink no longer available).

Second, an interactive database was created, listing details of specific actions, ranked for priority, for bats from the final PAS. Also, the CMAs and the LGAs involved for each action were placed on the web for public scrutiny mid 2007 on DECC threatened species website (last accessed 31 May 2010)

http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/pas_geo.aspx

Implementation of PAS actions

The implementation of PAS actions is an ongoing process. DECC (2007, pg 7) states that:

> The PAS contains many actions for many land tenures. Effective implementation of the PAS will require all land managers and stakeholders who have a responsibility or interest in threatened species conservation to get involved.

Further, DECC (2007, pg 7) states that:

> Many threatened species occur on private lands or have recovery requirements beyond the jurisdiction of DECC. Individual property owners, community groups and institutions such as universities are encouraged to identify actions that they can implement. DECC can help to identify priority species and habitats in a particular area, and recommend the necessary recovery and threat abatement strategies and actions to ensure their survival.

Note also that DECC (2007, pg 8) states:

> In addition to managing threatened species in national parks and reserves, DECC is responsible for research into, and the regulation and sustainable management of, threatened species on other land tenures. DECC also aims to undertake priority actions in these areas.

Monitoring the progress of PAS

DECCW is required to establish performance measures and report on achievements in implementation and

effectiveness of recovery strategies (DECC 2007). DECCW is also required to review PAS every three years, and report on the implementation of PAS strategies, and the status of each threatened species.

DEC (2006) stated:

> Monitoring the progress of all actions in the PAS will not be feasible due to their large number and dispersal. However, where practical DEC will liaise with other agencies to monitor the ongoing progress of strategies and actions they choose to implement. Public authorities, under the TSC Act, must provide an annual report to Parliament on progress in implementing recovery plan actions. Many of these actions are included in the PAS. Councils must also include in their annual state of the environment (SoE) reports a summary of actions taken to implement recovery plan measures. The DEC will also maintain PAS reporting and integrate it into its existing SoE and State of the Parks reporting obligations.

DECC will maintain a register of implemented PAS actions.

The PAS for bats

The PAS for bats consists of 377 PAS actions for the 21 NSW bat species listed as threatened in 2007, that were placed on the DECCW web site in mid 2007. Each PAS *action* takes the form of a short statement describing the action. The PAS actions for six threatened bat species are listed in Appendix 2 as examples. The full list is on the RZS website (rzsnsw.org.au). Currently there are 361 PAS actions, a reduction of 16 PAS actions following delisting of the Black Flying-fox (NSW Scientific Committee 2008).

PAS actions for bats arose from three sources:

1. The PAS for Grey-headed Flying-fox and the Black Flying-fox were derived from the list of recovery actions proposed in the draft Recovery Plan for the Grey-headed Flying-fox (Eby 2006). The process for devising these actions varied from that used for the other 19 bat species listed as threatened, in that they were negotiated over several months with a range of stakeholders who participated in the Recovery Team under the Plan. Members of the 18-strong, Grey-headed Flying-fox Recovery Team included representatives of commercial fruit growing industries, animal rehabilitation groups, conservation-based NGOs, local government, various state and federal wildlife and land management agencies, as well as researchers with specific expertise in the Grey-headed Flying-fox. Background information on the biology of Grey-headed Flying-fox, and the threats impacting on this species, were set out in the Plan, as were the objectives for ameliorating threats and actions for meeting them. The main benefits to this approach were that the PAS for this controversial species can be viewed in the context of a comprehensive program with broad stakeholder support, which will assist with its implementation;
2. The 7 PAS actions for the Hairy-nosed Freetail Bat were devised following consultation with DECCW staff for the draft PAS that was placed on public display in 2006;
3. PAS actions were developed for each of the 21 bat species listed as threatened in 2006, by seven bat specialists (the authors of this paper) plus the convenor during a two day workshop convened by DEC in August 2006. We addressed two issues: formulate actions that would be required to enable recovery of threatened bat species, and rank those actions into one of the three priority levels. Each PAS action was assigned to one of 22 standard categories of recovery strategies that were considered to be potentially relevant to bats (see Table 1).

Most of the 400 draft actions arising from the workshop were adopted and placed on the DECC website in mid 2007. The 21 actions developed by the workshop for the Hairy-nosed Freetail Bat (the only microchiropteran listed as Endangered in NSW) were not. The seven actions listed for that species on the DECCW website arose from the first draft of the PAS. The workshop developed 18 actions for the Inland Forest Bat *Vespadelus baverstocki*, and these were largely amalgamated into 8 on the website. The priority rankings of actions by the workshop were modified in the final PAS for bats, with a general downgrading of priority for many actions. Of the 400 draft actions derived from the workshop, 152 were high priority, 179 medium and 67 were low priority, compared to 119, 140 and 118 respectively for the 377 actions adopted on the website.

The number of priority actions associated with each standard recovery strategy are summarised for each threatened bat species in Table 1. Research and habitat management emerge as the two dominant themes in recovery strategies in the PAS for bats. Research actions were assigned to every threatened bat species (Figure 1). Research actions comprise 163 (45%) of the 361 actions. Actions for one or more of the seven recovery strategies for habitat management are assigned to all threatened bats, except the Golden-tipped Bat *Kerivoula papuensis*, with a total of 89 actions (Table 1 and Figure 2). Hollow-dwelling bats tended to have the greatest number of research actions assigned per species compared to the subterranean roosting species.

Recovery actions associated with a particular issue can appear under several different recovery strategies. For example, 20 recovery actions involving 16 bat species address impacts arising from application of pesticides and herbicides, and are listed under research, habitat management, and community and landholder education strategies.

High priority actions make up 152 of a total of 400 recovery actions from the workshop, compared to 117 of 361 finally adopted actions. High priority actions are dominated by research and habitat management strategies in the final PAS (Figure 2). The largest proportion of high priority actions are associated with the research recovery strategy (49, 41.8 %), followed by the recovery strategy "Habitat management: other" (17, 14.5%) and survey/mapping (12, 10.2 %).

In practice, the implementation of recovery actions for monitoring strategies and survey/mapping operate within a research framework, e.g. research will be required to devise effective monitoring programs that address issues of detectability and optimisation of sampling (Law 2004). Survey will be an essential part of monitoring for many hollow-using threatened bat species

Table 1. The number of priority actions (total=361 actions) for each of the 20 threatened bat species, listed for each of the 22 standard recovery strategies. Status refers to the schedules of Vulnerable (V) and Endangered (E) on the *Threatened Species Conservation Act 1995* (TSC Act). Note that several recovery strategies (e.g. "Diseases and pathogens") are not included as they were developed after the bat specialist workshop in 2006.

Species	Recovery strategies (n=22)																								
	TSC Act Status	Data recording & storage	Surveying/mapping	Monitoring	Habitat protection	Habitat management: feral control	Habitat management: weed control	Habitat management: advice to consent & planning authorities	Habitat management: fire	Habitat management: site protection	Habitat management: water	Habitat management: other	Habitat rehabilitation: restoration & regeneration	Community & landholder l education	Aboriginal liaison and interpretation	Research	Captive husbandry or propogation	Translocation and reintroduction	Conservation status review	Recovery plan preparation	Recovery team and action coordination	Prepare threat abatement plan	Other action	Total Actions
Large-eared Pied Bat *Chalinolobus dwyeri*	V		1	1	1			1		2		2		1		7							1	17
Hoary Wattled Bat *Chalinolobus nigrogriseus*	V		2	2	1			1				2		1		11								20
Little Pied Bat *Chalinolobus picatus*	V		1	1	1			1				4		3		13								24
Eastern False Pipistrelle *Falsistrellus tasmaniensis*	V		1		1			1				2		1		10								16
Golden-tipped Bat *Kerivoula papuensis*	V			1									1			4								6
Little Bentwing-bat *Miniopterus australis*	V	1	1	2	1	2	1		2	5		1		1		8								25
Eastern Bentwing-bat *Miniopterus schreibersii*	V	1		3	1	1	1		2	5		2		1		8								25
Beccari's Freetail-bat *Mormopterus beccarii*	V		1	1	1							3		3		11								20
Eastern Freetail-bat *Mormopterus norfolkensis*	V		1		1			1				3		1		11								18
Hairy-nosed Freetail Bat *Mormopterus eleryi*	E			2					1			2				2								7
Large-footed Myotis *Myotis macropus*	V		2					1		2	1	2	1			6								15
Eastern Tube-nosed Bat *Nyctimene robinsoni*	V		2	1	1		1	1		1		1	1	1		9							1	20
Eastern Long-eared Bat *Nyctophilus bifax*	V		2	1	2		1	1				2	1	1		9								20
Corben's Long-eared Bat *Nyctophilus corbeni*	V		4	1	1			1	2			4		1		9								23
Grey-headed Flying-fox *Pteropus poliocephalus*	V		4	2	2							1	1	5		13				1	1		1	31
Yellow-bellied Sheathtail-bat *Saccolaimus flaviventris*	V		1	1	1			1				2		3		12								21
Greater Broad-nosed Bat *Scoteanax rueppellii*	V		2		1			1				2		2		11								19
Common Blossom-bat *Syconycteris australis*	V		1	1	1		2	1	1			1	1	1		3								13
Inland Forest Bat *Vespadelus baverstocki*	V	1	1	1					1			1	1	1		1								8
Eastern Cave Bat *Vespadelus troughtoni*	V		1	1				1		3		1		1		5								13
Totals		3	28	22	17	3	6	13	9	18	1	38	7	28		163				1	1		3	361

and it is required to build on a baseline upon which monitoring operates. This could include monitoring hollow-using bats as derived from the DECCW NSW Wildlife Atlas records, although this will not be effective without systematic and ongoing contributions to the Atlas. This approach is, at best, only likely to detect broad changes in species distribution, so it would be no substitute for more rigorous methods.

Research and monitoring: key themes to emerge for PAS actions for bats

Research and monitoring is essential to overcome the dearth of knowledge about basic species ecology, distribution and habitat requirements. This gap in our

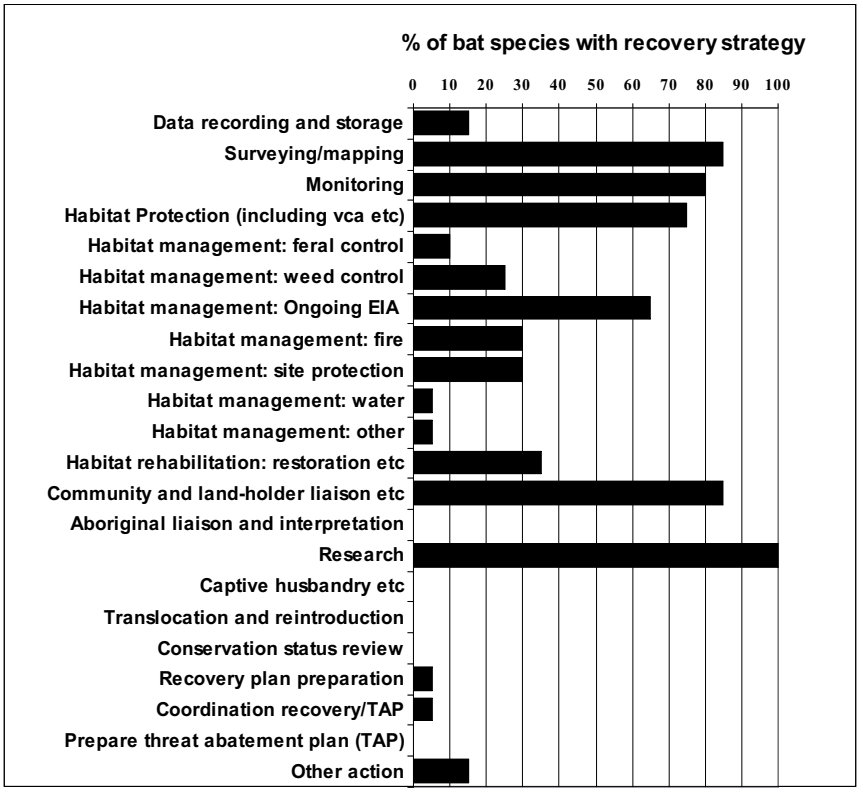

Figure 1. The percentage of threatened bat species (total of 20 species, i.e. 100%=20) to which each of 22 standard recovery strategies applies.

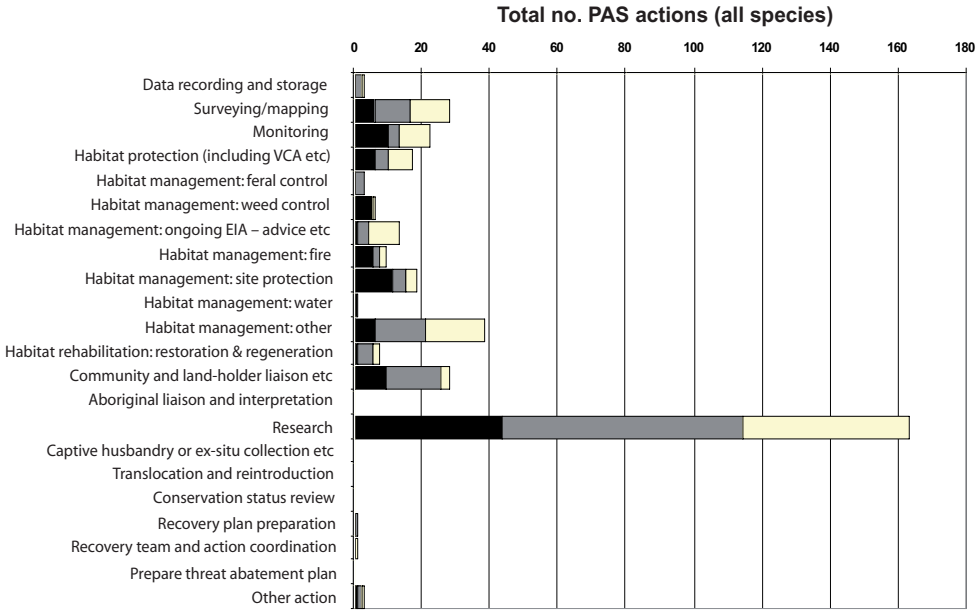

Figure 2. The number of PAS actions (total=361) allocated to 22 standard recovery strategies, all 20 threatened bat species combined, showing number of low (black), medium (grey) and high (clear) priority actions for each recovery strategy.

knowledge presents a major impediment to effective management of bats. This means that basic research is an essential first step to many practical management actions. A perception of research as being either esoteric or taking too long, and therefore irrelevant to practical management actions, remains an impediment to taking the first steps of effective recovery actions: defining the basic ecological requirements of each species and defining their distribution and habitat. While monitoring can indicate population declines, a concurrent research program is required to address the crucial question of the causes of any changes in the numbers in a population, or the distribution of a species, without which effective recovery programs cannot be formulated, nor assessed for their effectiveness.

Recurrent research themes for PAS recovery actions include:

- defining the roosting requirements – roost characteristics including roost microclimate, number and spatial arrangement of roosts and patterns of roost utilisation under different land-uses. This could be achieved by radio-tracking in different habitats;
- assessing the effects of habitat fragmentation on populations, which could entail identifying which species are uncommon in small habitat fragments, ideally under different configurations, and which species are reluctant to fly across open ground;
- study species biology, such as key habitat requirements, longevity, mortality, food taken and foraging distances;
- determining the impacts of pesticide and herbicide use on key aspects of bat ecology;
- studying the impacts of different burning regimes on foraging and roosting habitat.

Knowledge obtained from these studies is essential in providing direct guidance on a range of hands-on management practices. A radio-tracking study of roost trees selected by a hollow-using species can guide the formulation of burning regimes, monitoring programs, prescriptions for logging operations, protective measures in Property Vegetation Plans, impacts of invasive species, impact assessments for development proposals, and impacts of climate change on the species.

The importance of research and monitoring for recovery of threatened bats is reflected in the PAS for bats. Of the 361 actions, 45% are for research, which includes monitoring. Monitoring actions, associated either with research strategies or monitoring strategies, or both, are specified for all 20 threatened bats. Note that monitoring is specified as a research action for some species, e.g. Large-footed Myotis *Myotis macropus*, for which no action is listed under Monitoring strategy (Table 1). Of practical relevance here is that we point out that the PAS for bats does not indicate how research and monitoring actions are to be conducted for each species.

A generic monitoring action that has been identified for two-thirds of the threatened bat species is to "Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes". This illustrates the general nature of PAS recovery actions, i.e. a general statement, for which a detailed program must then be formulated to enable a practical implementation of the action. This represents a challenge, given that the majority of bats species roost in tree hollows that are dispersed through a forest or across paddocks. However, monitoring of hollow-using bats is feasible.

Implementation of PAS actions – some examples

This section presents three examples of the issues and practical considerations across species and recovery strategies in what could be expected in implementing the PAS.

Example 1: Implementing PAS actions for the Grey-headed Flying-fox

Of the 31 recovery actions for the Grey-headed Flying-fox, 9 have been, or are, in the process of being funded and implemented. They fall under the strategies of monitoring, research, survey/mapping and community/landholder education. None of the funded actions directly ameliorate the main threats to the species – habitat loss and degradation, and the killing of flying-foxes in commercial orchards. However, several provide essential information or resources for threat abatement, such as a project to identify significant foraging habitat for conservation (Eby and Law 2008), as well as research on flying-foxes in fruit crops, which may assist with a transition to non-lethal crop protection methods (McClelland *et al.* 2010). Another key area to be addressed is reversing the negative public attitudes to flying-foxes. These hostile attitudes act as an impediment to the community support needed for effective recovery.

Example 2: Ecological research and the Hairy-nosed Freetail Bat

An illustration of the potential for implementing a research program of hollow-using bats within realistic budgetary and time constraints is provided by the radio-tracking study by Pennay (2006) on the Hairy-nosed Freetail Bat, a small, rare and restricted hollow-using bat and the only microchiropteran listed as Endangered in NSW. Almost all ecological information known about this species to date was collected during this study, which included roosting preferences (tree hollows), maternity roosts, foraging and echolocation behaviour. Prior to this study, nothing was known of the ecology of this species other than the very sparse scatter of capture locations across arid and semi-arid areas of Queensland, the Northern Territory, northern South Australia and northern New South Wales. In NSW, the species was known from only five individuals caught at three locations. The single, 10-day study of this species had a modest budget funded by the Upper Darling Regional office of NSW National Parks and Wildlife Service, and it was able to generate new and valuable data. Likewise, most of our knowledge of the foraging and roosting behaviour for both the Little Pied Bat *Chalinolobus picatus* and Corben's Long-eared Bat was collected by Dominelli (2000) in a simple, low-budget radio-tracking study in the South Australian Mallee. The point here is that some bat research can be achieved in a short space of time with

modest budgets and therefore a strong case exists for funding a series of projects that implement PAS actions. While some of the actions will be long-term and require considerable funding, it is possible to get some PAS actions underway in the immediate future.

Example 3: Park Managers, Threatened Bats and the PAS

The PAS for bats provides the source for a range of management actions that can be enacted by managers of DECCW-estate across NSW. However, PAS actions often do not translate directly into hands-on management prescriptions for local ranger staff due to the want of critical baseline data for managing bat species and the need for preliminary investigations that will either provide input to, or will formulate, practical management actions.

To illustrate the way in which PAS actions can be applied, we focus on the Werakata State Conservation Area in the lower Hunter Valley, that was gazetted in 2007 (Department of Environment and Climate Change 2008). An important initial step is to undertake a baseline survey to assess the assemblage of bat species present in a particular reserve. A survey of Werakata found four threatened bat species: Grey-headed Flying-fox, Little Bentwing-bat *Miniopterus australis*, Eastern Bentwing-bat *M. schreibersii* and the Eastern Freetail-bat *Mormopterus norfolkensis* (DECC 2008). For the first three species, no known roosts were located within the reserve, but the search for roost sites for Bentwing-bats and flying-fox camp sites itself enacted several PAS actions for these species. For the two *Miniopterus* species, there are no other PAS habitat management actions that are applicable, and no specific management actions are currently required in the reserve. However, several PAS research actions relate to identifying foraging habitat and the impacts of different burning regimes on foraging habitat. Similarly for the Grey-headed Flying-fox, with the absence of a camp within the reserve, and no loss of foraging habitat due to the recent gazettal of the area, the habitat management PAS actions to be considered by ranger staff are limited: rehabilitation of previously cleared or disturbed ground to increase the extent of foraging habitat in the long term; avoid using barbwire in any fences being replaced; and take down any non-functioning barbwire fences that pose a potential for entanglement.

A different management approach is required for the fourth species, the Eastern Free-tail-bat, since this bat is a tree-hole roosting species. Although no known roosts have been located, it is likely that numbers of this species do roost within the reserve. A priority for ranger staff is to protect hollow-bearing trees, including dead trees, and consideration of the species requirements in fire management plans. Managers could initiate (e.g. allocate funding) any of 8 PAS actions (1 survey/mapping, 7 research) relevant to the species in the reserve. These relate to investigations of defining key ecological aspects of the species: e.g. long-term monitoring across land tenures, defining key habitat features, such as attributes of key roost trees and foraging areas, and impacts of fire regimes on foraging and roosting habitat. This could involve funding a radio-tracking study of the species to examine roost selection, foraging requirements and fire impacts on these aspects of the species but, in practice, our experience indicates that such funding tends is rarely available.

PAS and Forests NSW

Currently, the PAS has not been applied by Forests NSW. Instead, logging continues to operate under a Threatened Species Licence, whereby pre-logging surveys for a small number of threatened bat species are carried-out (Law 2004). However, 40 PAS actions highlight forestry activities (this includes 11 actions focused on private forestry operations) as a potential threat for 15 bat species. It specifically calls for research to investigate the impact of logging, as well as for monitoring the changing status of bat populations so that the changes can be incorporated into Forests NSW estate, along with other land tenures and an improved understanding of their ecology, to feed into management decisions.

Many actions at Forests NSW, such as forest-related bat research over the last 10 years, have taken place regardless of the PAS. It is noted that this research is now conducted by Department of Primary Industries (now Industry and Investment NSW) following the restructure of departments. Previous research examples include confirming the importance of mature trees as roosts for many bat species, with large hollows usually required for maternity roosts (Law and Anderson 2000; B. Law unpubl. data). For at least some species, regrowth forest is now known to provide habitat for foraging and breeding, not just for commuting (Law and Anderson 2000). Another important step has been to demonstrate that tracks and riparian zones facilitate the use of regrowth forest, but that the interior of dense regrowth forest is unsuitable for many species of foraging bats (Law and Chidel 2001; Law and Chidel 2002; Lloyd *et al*. 2006). On an individual species basis, research on the spider-feeding Golden-tipped Bat has found that recent management prescriptions have correctly targeted the protection of core rainforest roosting habitat for the species (Law and Chidel 2004). These studies are being complemented by a series of long-term research projects that are monitoring logging and burning impacts over extended time periods, either through changes in species activity levels or by annual banding of populations. These studies retain a high priority in the PAS, with the benefits of the PAS being that the actions are presented in a clear, open and consistent manner, providing decision makers with a tool to direct limited funds.

In addition to research, the PAS proposes landscape monitoring to investigate the effectiveness of forestry prescriptions beyond the scale of the individual study site. Such a shift in management focus to monitoring, underpinned by on-going research, has already been proposed (Law 2004). This indicates that incorporating PAS into future forest management is possible, especially if it can be incorporated into processes that relate to certification of ecologically sustainable practices. Sustaining monitoring programs will require government to commit considerable funds over decadal time-frames and careful coordination between departments will be needed.

Discussion

An objective of the PAS process was to overcome the slow pace of preparing Recovery Plans for each threatened species in NSW (DEC 2006; DECC 2007). The draft PAS, now in place, for all threatened NSW bat species, can be viewed as a set of *defacto* recovery plans in the sense that the actions listed for each species would provide the backbone of each recovery plan if they were to be prepared. The draft actions identify the information that must be obtained to enable the instigation and implementation of a recovery plan. The PAS for bats provides a strategic platform that enables managers, researchers and conservation groups across a range of land tenures and organisations to identify recovery actions, their priority, and relative importance for their management area. The PAS also provides a summary of those actions considered important by a group of bat specialists for the recovery of all threatened bat species. This provides a framework upon which research workers and funding bodies can also formulate their research programs to include practical recovery actions. In turn, this will enable more effective allocation of resources to threatened species recovery.

Some recovery strategies are common among all bats, such as research, which emerges as a primary means of moving along the path of bat conservation and recovery. The PAS is now a clear statement of the scale and range of issues necessary to be undertaken to tackle the matter of conserving this cryptic group of native mammals. As matters deteriorate, or improve, NSW conservation planners now have the single best statement of the 2010 state of play and the means of mitigating the threats faced by bats.

An advantage of the PAS process is that it has provided an opportunity to accelerate the process for threatened species recovery planning by identifying actions that are common to a range of species, not only bat species, but actions that are also applicable to a wider range of threatened species. For example, management of old growth forest elements, such as tree hollows, applies to many bat species, as well as to a wide range of threatened vertebrates and invertebrates. Likewise, management of the impacts arising from the application of pesticides and herbicides, for which there are recovery actions involving 16 bat species, could be integrated with studies of other faunal species. It therefore provides financial benefits through undertaking strategies for groups of like species at one time e.g. surveys, conservation of large, old trees, and community programs. It allows for a more comprehensive analysis of the performance of the recovery program as a whole. It also provides for greater inclusion of the community in recovery planning by identifying all priority actions that may be undertaken by university researchers, community Landcare groups, Catchment Management Authorities (CMAs), or private landholders.

Two major problems with the PAS process relate to funding, and priority assignment of species, for conservation management. Funding for most recovery actions has yet to be identified. It appears to largely depend on *ad hoc* funding decisions by individual land management agencies in different districts, where DECCW may have only an advisory role with such managers. Effective management of many NSW threatened bat species will need surveys or research that will take years to complete, yet there is no timetable for funding or initiation of the PAS. DECCW does not provide direct seeding funding for any PAS actions. However, the PAS does provide a tool to assist land managers in their planning for threatened species conservation. CMAs, for example, can use the PAS to decide which investment strategies and threatened species actions to implement. The PAS also provides a framework for bat researchers who seek conservation outcomes as an integral part of their programs.

Assigning priorities to the large number of proposed recovery actions across fauna and flora groups and land tenure appears to be an evolving aspect of the PAS process. Given that over 12,000 actions have been identified across all threatened species, how are the 361 bat actions to be ranked, and how are priorities to be allocated among the 20 bat species from among the more than 1000 threatened flora and fauna species, populations and ecological communities?

DECC (2007) states:

> DECC has started to link PAS actions to public authorities and other stakeholders who may be best placed to implement them. DECC intends to provide each potential conservation partner with a list of relevant PAS actions and work with them to select priority species and actions. DECC has already initiated this process with a number of CMAs and is helping them to develop threatened species programs that reflect priorities for their geographic areas. Many threatened species occur on private lands or have recovery requirements beyond the jurisdiction of DECC. Individual property owners, community groups and institutions such as universities are encouraged to identify actions that they can implement. DECC can help to identify priority species and habitats in a particular area, and recommend the necessary recovery and threat abatement strategies and actions to ensure their survival.

More generally, the issue of state wide co-ordination of species recovery actions is proposed to be addressed by integrating the PAS process with the NSW government's Natural Resource Commission's parallel *NSW Monitoring, Evaluation and Reporting Strategy* (MER), initiated in August 2005. The monitoring programs for this MER Strategy are currently being developed, but the extent that they will include regular assessments of threatened species recovery programs at the CMA level have yet to be resolved. One recommendation that we strongly advance here is to sustain those long-term research and monitoring programs that already exist, because they are the ones most likely to provide the best, long-term and consistent results. We also recommend that a Bat Recovery Steering Committee be established to provide specialist assistance for state-wide co-ordination of bat recovery strategies across all land tenures. This committee would consist of personnel who are either funded for the role or, if DECCW employees, have time allocated for such a role. The formation of the Steering Committee is consistent with the specialised input requested by the Director-General (DECC 2007):

> To be successful, the PAS needs support from all levels of government and the community whose expertise and involvement will be crucial in implementing actions requiring specialised knowledge of NSW regions, landscapes, and threatened plants and animals.

A major challenge to ascertaining the effectiveness of the PAS process is that the outcomes have yet to be clearly defined. In one sense, the recovery of threatened species and improved conservation status are clear indications of success. It is notable that no bat species have been removed from the threatened list since its inception in 1992, except for the Black Flying-fox. In reality, the success of PAS will be difficult to define, particularly given that DECCW will only attempt to review threatened species status for those species for which information becomes available (DECC 2007, pg 9).

Another issue is the lead times envisaged for preparation and implementation of the current 14 Threat Abatement Plans (TAPs). For example, preparation of the TAP for the Key Threatening Process of loss of hollow-bearing trees – arguably one of the most critical for the majority of threatened bats – is currently not scheduled for completion until 2010 (DECC 2007).

What the PAS for bats does not cover

PAS reflects a focus on the 20 threatened bats, but not the full spectrum of bats, i.e. an additional 19 species of NSW bat species. We point out that many of these bat species, although not listed as threatened, are also impacted by the continuing loss and degradation of habitat, plus the added impost of climate change. The standard PAS action of *Conservation Status Recovery Strategy* enables a review of threatened species. However, the PAS considers only whether threatened species should be de-listed and does not re-evaluate the threat status of species not listed as threatened.

The PAS for bats does not address the value for the recovery strategies of studying and conserving common bat species, or even uncommon, but non-listed, bat species. While there is a clear case for studying the specialised requirements of threatened species, common species can yield statistically significant results because they are more readily studied, enabling comparisons between the published papers on bat ecology and conservation for both threatened and non-threatened species both in Australia and throughout the world. In fact, the world interest in bat conservation provides both a source of knowledge and ideas for studying and managing bats. We particularly emphasise that studying only threatened species out of the context of all bats will not be the most efficient way to keep the other bats from entering the threatened species schedules, or even recovering and delisting those that are already on the schedules. A recovery of threatened bat species in a location is therefore far more likely to be successful when all bat species are studied to elucidate their ecological attributes and assess the conservation and management options. This matter can be constructively considered in the context of Key Threatening Processes, where such issues as the loss of hollow-bearing trees are most effectively studied with both threatened species and those bats not listed as threatened.

Concluding Remarks

The PAS has provided the opportunity to assess the state of play in 2006–07, with details updated in 2010, for bat conservation in New South Wales. It is rare to have such an opportunity on a State wide basis. The last was in 1992 when the current list of threatened bats was prepared (Lunney *et al.* 2000), but that listing process neither identified threats nor actions to ameliorate them. We consider that bat conservation will languish unless action is taken to give effect to the PAS. The PAS has highlighted the scale of the issues facing all 20 bat species listed as threatened. To that we add the other 19 species of NSW bats, and re-iterate that some of the most far-reaching research has been conducted on the more common species because one can achieve a sufficient sample size to arrive at reliable answers, such as roost preferences and roost conditions.

The PAS for bats is a considerable step forward in that it represents the first official DECCW statement of recovery actions required for *all* threatened bat species in NSW. This means that managers can now address the official recovery actions, rather than having to evaluate *ad hoc* proposals advanced by individual researchers or conservation planners. This is a necessary step forward for bat conservation. It is an essential precursor to the much larger task of the design and implementation of the identified actions.

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Appendix 1

Extracts from DECC documentation of the PAS process

This appendix sets out extracts from the official documentation of the PAS process for those who are unfamiliar with the changes to the management of NSW threatened fauna, for interstate workers, and for future workers who might not have access to the current information on the DECCW website. The documentation is provided by DEC (2006) for the draft PAS (weblink no longer available) and DECC (2007) for the current status of the PAS, which is currently on the DECCW threatened species website http://www.environment.nsw.gov.au/resources/threatenedspecies/threatspecpas07168.pdf (last accessed 26 May 2010).

The following formal statement reflects the intent of some of the 2004 amendments to the NSW *Threatened Species Conservation Act 1995*, and it set the stage for a review of the issues facing the threatened bats of NSW (DECC 2007):

> In 2004, the NSW government reformed the TSC Act to better integrate threatened species with rural and urban land use planning and natural resource management, and with improvements to the development assessment process. To complement these reforms, a draft NSW Threatened Species Priorities Action Statement (PAS) was introduced in May 2006. The TSC Act requires the Director General of the Department of Environment and Climate Change (DECC) to prepare and adopt a PAS that:
>
> - sets out the recovery and threat abatement strategies to be adopted for each threatened species
> - establishes relative priorities and actions to implement the above strategies
> - establishes performance indicators to report achievements in implementing recovery and threat abatement strategies and their effectiveness
> - contains a status report on each threatened species (where information is available)
> - sets out clear timetables for recovery and threat abatement planning and achievement.

The Department of Environment and Climate Change (DECC 2007) statement: *Introducing the NSW threatened species priorities action statement (PAS)* is explicit on key points relevant to the perceived need for change. High among that list is the following statement from the executive summary:

> Previously, the TSC Act required the preparation of a recovery plan for each threatened species, population or ecological community and a threat abatement plan for each listed key threatening process (KTP). However, as the number of threatened species listed under the Act grew, this approach became increasingly unworkable. The Government recognised the need for a new approach. Actions for all threatened species needed to be readily identified and coordinated, so the impacts on them could be reduced by integrating planning for recovery of threatened species with urban and rural land use planning and decision-making, and landscape restoration investments. As a result, the NSW Threatened Species Priorities Action Statement (PAS) was conceived to provide a strategic approach to threatened species recovery which could be used by all members of the community. The draft PAS was publicly exhibited in May 2006.

Our concern here is not with the legislation or its implementation, but with how bats are seen in the new framework of the PAS. Among the principles in the introduction to the PAS (DECC 2007) are three that bear directly on our reason for writing this paper. They are:

- To identify and communicate what actions need to be implemented and where they should be undertaken.
- To improve management of threatened species by increasing knowledge of their biology and ecology and the processes that threaten them.
- To ensure this information is communicated to people or organisations involved in conserving threatened species.

Previously the TSC Act required preparation of a recovery plan for all listed NSW threatened species. The DECC (2007) paper stated that:

> The PAS identifies threatened species, populations and ecological communities for which a single species, multi-species, multi-community or regional recovery plan is the most suitable response. Recovery plans are most suitable for species that: are iconic, or have complex conservation issues involving a suite of management actions, or require the input and agreement of multiple stakeholders including Aboriginal communities.

DECC (2007) further stated that it intends to review, initiate or complete 31 recovery plans within the first three years of the PAS, comprising 27 single species or ecological community recovery plans and four multi-species, multi-community and regional recovery plans. The scale of the issue that the DECC (2007) document identified was given as the opening statement of its introduction:

> In NSW over 840 species, 35 populations and 75 ecological communities are threatened. They are classified under the NSW *Threatened Species Conservation Act 1995* (TSC Act) as either 'critically endangered,' 'endangered' or 'vulnerable.' Many of these species are also considered threatened nationally and are listed under the Commonwealth's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Over 70 other species are presumed to be extinct. In addition to lists of threatened species, 30 key threatening processes (KTPs) are identified in the TSC Act. A KTP adversely affects threatened species, or could cause those that are not threatened to become threatened. If left unchecked, KTPs will inevitably cause the extinction of species, populations and communities.

The PAS approach has been presented as a new means to tackle an issue that has been seen as being way beyond the scope of the recovery plan process. We are not investigating that matter, we have participated in the PAS process with the result that we can report [in 2007] on the scale of the issues facing the 21 species of threatened bats in NSW is a single paper. This paper was prepared in 2007, and has been updated for publication. One species, the Black Flying-fox, was removed from the list of threatened species in 2008. Hence the 21 in the previous sentence, but that number is 20 throughout the text of this paper, and the figures and table.

Appendix 2

The website of the Royal Zoological Society of NSW (rzsnsw.org.au) carries the complete PAS for bats from the DECC website, consisting of the 361 priority recovery actions statements determined by DECC (now DECCW) for each of the 20 NSW bat species listed as threatened on the TSC schedules, with species threat status shown in brackets. This appendix carries six species, representative of the spectrum of the threatened bats in NSW. The first column shows the standard recovery strategy in italics, under which each associated PAS action is listed; the second column shows the priority assigned to each action. The 16 PAS actions for the Black Flying-fox are listed on the RZS website, but no longer form part of the PAS for bats, following delisting of that species in 2008.

Abbreviations are: CAP – Catchment Action Plan; CMA – Catchment Management Authority; EIS – Environmental Impact Assessment; HCV – high conservation value; JMA – joint management agreements, between public authorities and DECCW; LEP – Local Environment Plan; PVP – Property Vegetation Plan; VCA – voluntary conservation agreements, between private landowners and DECCW. Biobanking is another recent initiative under the TSC Act that can be seen at http://www.environment.nsw.gov.au/biobanking/biobankscheme.htm, last accessed 26 May 2010.

Common Blossom-bat *Syconycteris australis* (Vulnerable)	
Community and land-holder liaison/awareness and/or education	
Develop and promote State-wide bat awareness programs for schools; CMAs; landholders and industry groups etc.	Low
Habitat management: Fire	
Develop burning strategies that reduce impacts on preferred habitat in known foraging areas.	Low
Habitat Management: Ongoing EIA – Advice to consent and planning authorities	
Prepare EIA guidelines which address the retention of a mosaic of nectar-producing trees and rainforest roost habitat.	Medium
Habitat Management: Other	
Ensure a mosaic of nectar-producing trees and shrubs; esp. in coastal heath paperbark swamp as well as rainforest roost habitat. Give high priority in PVP assessments; or other assessment tools.	High
Habitat management:Weed Control	
Control coastal weed species e.g. Bitou Bush; but avoid aerial spraying during the flowering season of important heath species as herbicides can directly collect in flowers that are fed upon at night.	Low
Identify the impact on bats of weed-spraying at different times of the year.	High
Habitat Protection: (inc vca/ jma/ critical habitat nomination etc)	
Promote the conservation of these areas using measures such as incentive funding to landholders; off-setting and biobanking; acquisition for reserve establishment or other means.	Medium
Habitat Rehabilitation/Restoration and/or Regeneration	
Initiate and support rainforest and heath regeneration projects where coastal habitat has been cleared and fragmented.	Medium
Monitoring	
Undertake long-term monitoring of select populations cross tenure.	Low
Research	
Determine the extent of use of revegetation in development areas that are subject to high ambient light levels.	Medium
Determine the effectiveness of PVP assessment; offsets and actions for bats.	High
Identify critical foraging habitat in November when bats are breeding; but when few heath species are flowering.	High
Survey/Mapping and Habitat assessment	
Identify areas of private land that contain patches (including small) of littoral rainforest as areas of HCV in planning instruments and land management tools (e.g. LEP; Catchment Action Plans; PVPs).	Medium
Corben's Long-eared Bat *Nyctophilus corbeni* (formerly Greater Long-eared Bat *Nyctophilus timoriensis*) (Vulnerable)	
Community and land-holder liaison/ awareness and/or education	
Develop and promote a State-wide bat awareness programs for schools; CMAs; landholders and industry groups etc.	Medium
Habitat management: Fire	
Develop "interim" minimum fire regime recommendations based on best available knowledge.	Medium

Develop hazard reduction fire management regimes to protect foraging habitat.	High
Habitat Management: Ongoing EIA – Advice to consent and planning authorities	
Prepare EIA guidelines addressing key habitat requirements; including retention of adequate densities of hollow-bearing trees and undisturbed understorey vegetation.	High
Habitat Management: Other	
Encourage the protection and enhancement of understorey vegetation.	Medium
Encourage retention of the largest hollow bearing trees.	High
In cypress–ironbark forest subject to logging and other timber extraction activities (e.g. firewood collection); ensure the retention of all large eucalypt trees (including standing dead trees).	High
Review current logging prescriptions. If insufficient; modify to ensure adequate retention of hollow-bearing trees; recruit trees and undisturbed foraging habitat.	High
Habitat Protection: (inc vca/ jma/ critical habitat nomination etc)	
Maintain or improve the value of identified HCAs using measures such as incentive funding to landholders; off-setting and biobanking; acquisition for reserve establishment or other relevant options.	Medium
Undertake long-term monitoring of populations across tenures.	Medium
Research	
Research the effects of grazing on this species; such as changes to understorey structure and recruitment of roost trees.	Medium
Study the biology; ecology and habitat requirements of the species in different western environments; such as mallee and ironbark–cypress forest.	Medium
Quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.	Low
Research the effectiveness of rehabilitation measures such as revegetating and installing bat boxes in degraded landscapes to increasing local bat populations.	Low
Research the degree of long-term fidelity to roost trees and roosting areas in order to assess their importance and the effects of their removal.	High
Research the effects of fragmentation; including genetic isolation; movement among fragments and persistence in fragments that vary in size and connectivity.	High
Research the impacts of different fire regimes.	High
Research the roosting ecology of this species. For example; to identify the attributes of key roosts.	High
Research using radio-tracking the foraging range and habitat; and other key habitat components.	High
Survey/Mapping and Habitat assessment	
Conduct surveys in preferred and potential habitat throughout the species range.	High
Identify areas of private land containing high densities of large; hollow-bearing trees (i.e. near to natural densities) as areas of high conservation value for this species.	Medium
Identify large remnants (i.e. > 100 ha) on private property as high conservation value for this species.	Medium
Identify vegetation in a wide strip bordering creek and rivers on the Western Slope and Plains of NSW as high conservation value for this species.	High
Eastern Bentwing-bat *Miniopterus schreibersii oceanensis* (Vulnerable)	
Community and land-holder liaison/ awareness and/or education	
Promote bats throughout the rural community as ecologically interesting and important; but sensitive to disturbance at caves/disused mine tunnels.	Medium
Data recording and storage	
Compile register of all known roost sites in natural and artificial structures including current and historical data and identify significance of roost; e.g. maternity; hibernation; transient roost.	Medium
Habitat management: Feral Control	
Control foxes and feral cats around roosting sites; particularly maternity caves and hibernation sites.	Medium
Habitat management: Fire	
Exclude prescription burns from 100m from cave entrance; ensure smoke/flames of fires do not enter caves/ roosts in artificial structures.	Low
Prepare fire management plans for significant roost caves; disused mines; culverts; especially maternity and winter roosts.	Low
Habitat Management: Other	
Ensure protection of known roosts and forest within 10 km of roosts in PVP assessments (offsets should include nearby remnants in high productivity) and other environmental planning instruments.	Medium
Prepare management plans for significant bat roosts especially all known maternity colonies and winter colonies.	Low
Habitat management: Site Protection (e.g. Fencing/Signage)	
Search for significant roost sites and restrict access where possible (e.g. gating of caves). Significant includes maternity; hibernation and transient sites including in artificial structures.	Medium

Identify and protect significant roost habitat in artificial structures (e.g. culverts; old buildings and derelict mines).	Low
Restrict access where possible to known maternity sites. (e.g.: signs; bat-friendly; preferably external gates at caves).	Low
Restrict caving activities at significant roosts during important stages of the annual bat life cycle (e.g. winter hibernation; summer maternity season).	Low
Restrict caving activity during critical times of year in important roosts used by species; particularly maternity and hibernation roosts.	Low
Habitat management:Weed Control	
Undertake non-chemical removal of weeds (e.g. lantana; blackberry) to prevent obstruction of cave entrances.	Low
Habitat Protection: (inc vca/ jma/ critical habitat nomination etc)	
Promote the conservation of these key roost areas using measures such as incentive funding to landholders; offsetting and biobanking; acquisition for reserve establishment or other means.	Medium
Monitoring	
For roost caves vulnerable to human disturbance; monitor their visitation by people; particularly during winter and spring/summer maternity season and in school holidays.	Low
Monitor the breeding success of a representative sample of maternity colonies in cave roosts over a number of years to determine the viability of regional populations.	High
Regular censuses of maternity colonies (Wee Jasper; Bungonia; Willi-Willi; Riverton) and other key roosts in network; especially where there are population estimates from banding in the 1960s.	High
Research	
Confirm species taxonomy of NSW populations; relative to other Australian populations.	Medium
Determine the effectiveness of PVP assessment; offsets and actions for bats.	Medium
Establish a gating design for disused mines across species range that will not adversely impact species. Consultation with cave bat specialist prior to any gating operations.	Medium
Identify the susceptibility of the species to pesticides.	Medium
Research the effect of different burning regimes on cave disturbance and surrounding foraging habitat.	Medium
Research to identify important foraging range and key habitat components around significant roosts.	Medium
Study the ecological requirements of maternity colonies and their environs and migratory patterns.	Medium
Measure genetic population structure among cave roosts of maternity colonies to estimate dispersal and genetic isolation; and vulnerability to regional population extinction.	Low
Eastern Freetail-bat *Mormopterus norfolkensis* (Vulnerable)	
Community and land-holder liaison/ awareness and/or education	
Develop and promote State-wide bat awareness programs for schools; CMAs; landholders and industry groups etc.	Medium
Habitat Management: Ongoing EIA – Advice to consent and planning authorities	
Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups; species diversity; structural diversity. Give priority to largest hollow bearing trees.	High
Habitat Management: Other	
Ensure the Code of Practice for private native forestry includes adequate measures to protect large; hollow-bearing trees and viable numbers of recruit trees.	Medium
Ensure the largest hollow bearing trees; inc. dead trees and paddock trees; are given highest priority for retention in PVP assessments. Offsets should include remnants in high productivity.	High
Identify areas of private land that contain high densities of large hollow-bearing trees as areas of high conservation value planning instruments and land management negotiations e.g. LEP; CAPs; PVPs.	High
Habitat Protection: (inc vca/ jma/ critical habitat nomination etc)	
Promote the conservation of these private land areas using measures such as incentive funding to landholders; off-setting and biobanking; acquisition for reserve establishment or other means.	High
Research	
Identify important foraging range and key habitat components for this species.	Medium
Investigate the effectiveness of logging prescriptions.	Medium
Research the effect of different burning regimes.	Medium
Research the effectiveness of rehabilitation measures intended to increase bat populations in degraded landscapes; such as revegetating and installing bat boxes.	Medium
Study the ecology; habitat requirements and susceptibility to logging and other forestry practices of this little-known species.	Medium
Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.	Medium

Quantify any benefits of local bat populations to reducing the impact of insect pests on commercial crops.	Low
Identify the effects of fragmentation in a range of fragmented landscapes i.e. the farmland/forest interface and the urban/forest interface e.g. movement and persistence across a range of fragment sizes.	High
Research the degree of long-term fidelity to roost trees and roosting areas in order to assess their importance and the effects of their removal.	High
Research the roosting ecology of tree-roosting bats. For example identifying the attributes of key roosts.	High
Survey/Mapping and Habitat assessment	
Better define species distribution through survey in coastal lowlands on- and off-reserve.	Medium
Identify the susceptibility of the species to pesticides.	Medium
Grey-headed Flying-fox *Pteropus poliocephalus* (Vulnerable)	
Community and land-holder liaison/ awareness and/or education	
Develop materials for public education & provide them to land managers & local community groups working with controversial flying-fox camps; highlighting species status; reasons for being in urban areas; reasons for decline etc.	Medium
Monitor public attitudes towards flying-foxes.	Medium
Review & evaluate camp site management activities; summarising outcomes of past experiences at controversial camps. Noise impacts on neighbours of camps to be considered. For use in managing future conflicts with humans at flying-fox camps.	Medium
Conduct periodic range-wide assessments of the population size of Grey-headed Flying-foxes to monitor population trends.	Low
Provide educational resources to improve public attitudes toward Grey-headed Flying-foxes.	High
Coordinate the recovery and/or threat abatement program	
Grey-headed Flying-fox National Recovery Team to undertake an annual review of the national recovery plan's implementation.	High
Habitat Management: Other	
Enhance and sustain the vegetation of camps critical to the survival of Grey-headed Flying-foxes.	Low
Habitat Protection: (inc vca/ jma/ critical habitat nomination etc)	
Protect and enhance priority foraging habitat for Grey-headed Flying-foxes; for example through management plans; local environmental plans and development assessments; and through volunteer conservation programs for privately owned land.	Low
Protect roosting habitat critical to the survival of Grey-headed Flying-foxes; for example through management plans; local environmental plans and development assessments; and through volunteer conservation programs for privately owned land.	Low
Habitat Rehabilitation/Restoration and/or Regeneration	
Increase the extent and viability of foraging habitat for Grey-headed Flying-foxes that is productive during winter and spring (generally times of food shortage); including habitat restoration/rehabilitation works.	High
Monitoring	
Develop and implement a grower-based program to monitor trends in damage to commercial fruit crops by flying-foxes; and use the results to monitor the performance of actions to reduce crop damage.	High
Systematically document the levels of flying-fox damage to the horticulture industry within the range of the Grey-headed Flying-fox.	High
Other Action	
Develop guidelines to assist land managers dealing with controversial flying-fox camps.	Medium
Recovery Plan Preparation: Single species	
Complete national recovery plan in 2007	Medium
Research	
Assess the impacts on Grey-headed Flying-foxes of electrocution on powerlines and entanglement in netting and barbed wire; and implement strategies to reduce these impacts.	Medium
Describe the species; age structure & demographics of flying-foxes killed in fruit crops to improve the understanding of the impact by assessing trends in the species; sex; age & reproductive status of animals killed on crops.	Medium
Determine characteristics of roosting habitat for Grey-headed Flying-foxes; exploring the roles of floristic composition; vegetation structure; microclimate and landscape features; and assess the status of camps.	Medium
Investigate the age structure and longevity of Grey-headed Flying-foxes.	Medium
Assess the impacts Grey-headed Flying-fox camps have on water quality; and publish results in a peer-reviewed journal.	Low
Develop methods to monitor landscape scale nectar availability trends; to explain/potentially predict crop damage trends where crop protection is absent; & promote importance of foraging habitat productive in seasons critical to the horticulture industry.	Low
Investigate between-year fidelity of Grey-headed Flying-fox individuals to seasonal camps.	Low

Investigate the differences in genetic relatedness; sex; age etc. between sedentary and transient Grey-headed Flying-foxes.	Low
Investigate the genetic structure within Grey-headed Flying-fox camps; including levels of relatedness within and between members of adult groups; occupants of individual trees etc.	Low
Investigate the patterns of juvenile Grey-headed Flying-fox dispersal and mortality; allowing identification of the specific habitat requirements of juveniles.	Low
Develop and promote incentives to reduce killing of flying-foxes in commercial fruit crops.	High
Develop methods for rapid estimates of flying-fox damage on commercial crops; allowing the long-term monitoring of industry-wide levels and patterns of flying-fox damage.	High
Review and improve methods used to assess population size of Grey-headed Flying-foxes.	High
Survey/Mapping and Habitat assessment	
Establish & maintain a range-wide database of Grey-headed Flying-fox camps; including information on location; tenure; zoning & history of use; for distribution to land management/planning authorities; researchers & interested public.	Medium
Improve knowledge of Grey-headed Flying-fox camp locations; targeting regional areas and seasons where information is notably incomplete; such as inland areas during spring and summer.	Low
Identify the commercial fruit industries that are impacted by Grey-headed Flying-foxes; to provide an information base for use by the various stakeholders.	High
Set priorities for protecting foraging habitat critical to the survival of Grey-headed Flying-foxes and generate maps of priority foraging habitat.	High
Large-footed Myotis *Myotis macropus* (formally *Myotis adversus*) (Vulnerable)	
Habitat Management: Ongoing EIA – Advice to consent and planning authorities	
Prepare EIA guidelines which address the retention of hollow bearing trees maintaining diversity of age groups; species diversity; structural diversity. Give priority to largest hollow bearing trees.	Low
Habitat Management: Other	
Promote roosting habitat in new artificial structures within the species range.	Medium
Ensure the largest hollow bearing trees in riparian zones are given highest priority for retention in PVP assessments or other land clearing assessment tools.	Low
Habitat management: Site Protection (e.g. Fencing/Signage)	
Identify; protect and enhance roost habitat beneath artificial structures (e.g. bridges); especially when due for replacement; and assess effectiveness of the actions.	Low
Study the ecology; habitat requirements and susceptibility to logging and other forestry practices of this little-known species.	High
Habitat Management:Water	
Better regulate pollution of waterways e.g. sewage and fertilizer run-off (eutrophication) and pesticide/herbicide leakage (chemical pollution) and thermal pollution.	Low
Habitat Rehabilitation/Restoration and/or Regeneration	
Encourage recovery of natural hydrological regimes; including retention and rehabilitation of riparian vegetation.	Medium
Research	
Determine susceptibility to logging.	Medium
Investigate the effectiveness of logging prescriptions.	Medium
Research to identify important foraging range and key habitat components for this species. Identify the importance of riparian vegetation to the species.	Medium
Identify the spatial population structure; including genetic isolation; movement and persistence across the species range.	Low
Undertake long-term monitoring of populations cross tenure in conjunction with other bat species to document changes.	Low
Resolve species taxonomy by morphology/genetics and reassess conservation status.	High
Survey/Mapping and Habitat assessment	
Assess the importance by survey of estuaries and other tidal waterways for the species across its range.	High
Survey large inland waterways for this species to determine distribution in Murray Darling Basin.	High