Recovery plan for cave-dwelling bats, *Rhinolophus philippinensis, Hipposideros semoni* and *Taphozous troughtoni* 2001–2005

Prepared by Mr Bruce Thomson, Dr Chris Pavey and Mr Terry Reardon in collaboration with the cave-dwelling bats recovery team

Queensland Government
Queensland Parks and Wildlife Service

Natural Heritage Trust
Helping Communities Helping Australia

Recovery plan for cave-dwelling bats, *Rhinolophus philippinensis, Hipposideros semoni* and *Taphozous troughtoni* 2001–2005

© The State of Queensland, Environmental Protection Agency

Copyright protects this publication. Except for purposes permitted by the Copyright Act, reproduction by whatever means is prohibited without the prior written knowledge of the Environmental Protection Agency. Inquiries should be addressed to PO Box 155, BRISBANE ALBERT ST, Qld 4002.

Prepared by: Mr Bruce Thomson, Dr Chris Pavey and Mr Terry Reardon in collaboration with the cave-dwelling bats recovery team.

Copies may be obtained from the:
Executive Director
Queensland Parks and Wildlife Service
PO Box 155
Brisbane Albert St QLD 4002

Disclaimer:
The Queensland Parks and Wildlife Service publishes recovery plans to detail the actions needed for the conservation of threatened native wildlife.

The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved, and may also be constrained by the need to address other conservation priorities. Approved recovery plans may be subject to modification due to changes in knowledge and changes in conservation status.

Publication reference:
Recovery plan for cave-dwelling bats, *Rhinolophus philippinensis, Hipposideros semoni* and *Taphozous troughtoni* 2001–2005*.* Unpublished report to Environment Australia, Canberra.

Recovery plan for cave-dwelling bats, *Rhinolophus philippinensis, Hipposideros semoni* and *Taphozous troughtoni* 2001–2005

Contents

Summary

Description and status of species

Three species of cave-dwelling bats have been included in this plan (Table 1). Two of these species, *Hipposideros semoni* and *Rhinolophus philippinensis*, have distributional ranges (excluding extra-limital distributions) which are centred on the Cape York Peninsula, Wet Tropical Rainforest and Einasleigh Uplands biogeographical regions. The third species*, Taphozous troughtoni*, has been recorded in the Mount Isa Inlier Biogeographical Region however distributional information for this species is far from complete. Species distribution is shown in Figures 1-3.

All three species are known to use natural cave systems and man-made structures, including abandoned mines, as roost and maternity sites and have been identified as being subject to the same threatening processes as described in *The Action Plan for Australian Bats* (Duncan et al. 1999). These species also share a common group of stakeholders who will be involved in implementing recovery actions. They therefore present a convenient and reasonably discrete group of threatened species for which a single recovery team will be established and are treated here in a single recovery plan.

Table 1. *Species covered in the plan and their conservation status*

Species	**Status - *The Action Plan for Australian Bats* (Duncan et al. 1999)**	**Status - *Nature Conservation Act 1992* (Qld)**
Hipposideros semoni	Endangered (C2a, D)	Vulnerable
Rhinolophus philippinensis	Endangered (C2a)	Rare
Taphozous troughtoni	Critically Endangered (B1, B2c)	Endangered

It is expected that these species will be listed in the Schedules of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth). It is anticipated that the status of *H. semoni* and *R. philippinensis* will remain as described in *The Action Plan for Australian Bats* whereas the status for *T. troughtoni* may be downgraded to Vulnerable following studies that were undertaken during the development of this recovery plan.

Taxonomy

All three species are subject to taxonomic uncertainty. At present, the genetic and morphological distinction between the two recognised ‘forms’ of *Rhinolophus philippinensis* are not clear, nor are the distinctions between *Taphozous troughtoni* and *T. georgianus.* The taxonomic relationship between *Hipposideros semoni* and *H. stenotis* also requires clarification, as do the relationships of allopatric populations within *H. semoni*. The clarification of taxonomic groups and the development of methods which allow unequivocal identification of each taxon in the field are key steps in the recovery of these taxa.

Habitat requirements and limiting factors

All three species are thought to be obligate cave dwellers (Pavey 1995, Hall 1995) although other man-made structures such as abandoned mines, tunnels, houses and culverts have also been recorded (Hall 1995). Maternity sites for these species have

not been documented but are thought to be limited to caves and abandoned mines where micro-climatic factors are suitable. All species forage in the surrounding environments at night and employ a range of foraging strategies. *H. semoni* has been recorded as foraging close to the ground and around vegetation (Hall 1995). *R. philippinensis* has been recorded foraging below the forest canopy and occasionally at low levels in open areas (Pavey 1995) while members of the genus *Taphozous* usually fly well above the tree canopy and exhibit a fast and direct flight.

A lack of accurate data on the distribution and abundance of these species makes assessment of their conservation status quite difficult. Survey work specifically designed to identify with greater certainty the distribution of species and their range of roost and maternity sites will be undertaken as a priority in the recovery process.

Current information presented here and in the Commonwealth Action Plan for Australian Bats identifies the following threats for these species:

1. The destruction or disturbance of roost and maternity sites. Disturbance of roosting and maternity populations in natural cave systems and old, abandoned mine sites may occur through insensitive commercial, recreational or scientific activities by visitors or as a result of new or renewed mining or quarrying activities. An increase in the numbers and activity of predators such as feral cats can also be disruptive and potentially threaten the viability of some sites.

2. The destruction of old mines during rehabilitation works. In the past, many old mines have been destroyed during rehabilitation works carried out by mining companies, State Government authorities and other land management agencies.

3. *Hipposideros semoni* is considered to be vulnerable to habitat disturbance however this threat is not fully delineated since the habitat requirements and distribution of this species remain unclear.

All species under consideration in this plan are usually identified in survey work from their roost sites or are captured in proximity to roost sites or in environments where cave formations or suitable man-made structures are known to occur. It would therefore seem that roost sites may be a critical factor in determining local distribution patterns while climate, vegetation and other related factors determine the broad scale limits to distribution. The loss of suitable roost and maternity sites, however, may lead to the local extinction of populations and affect their overall distribution within otherwise suitable environments.

Recovery plan objectives

Overall objectives

- To clarify the taxonomic status of the species.

- To ensure that priority roost and maternity sites throughout the species' distributions are protected from identified threats.

- To document aspects of species ecology necessary for effective management and conservation.

These actions should significantly improve the conservation status of the species.

Specific objectives during the life of the current recovery plan

1. To establish the status of poorly known species and to identify appropriate species management units within two years of implementation of the plan (required for objective 3).

2. To gather the necessary biological data from current records and through new, targeted field work for the effective conservation management of the species.

3. To implement conservation strategies or on-ground conservation works in priority sites where the species occur. These initiatives will be designed to mitigate identified threatening processes.

4. To identify trends in the species' abundance at priority sites across their distributional ranges after the instigation of conservation strategies or on-ground conservation works.

5. To encourage community participation in and understanding of the recovery process and the conservation issues related specifically to cave-dwelling bats.

Recovery criteria

1. All species are taxonomically delineated.

2. Species' distribution ranges are identified.

3. Roost and maternity sites for species are identified and prioritised.

4. Species' roost site characteristics, diet and habitat use are identified.

5. On-ground works are completed, or agreed conservation management practices implemented at priority roost and maternity sites.

6. At sites where on-ground management practices or works have been implemented, follow-up surveys indicate that population size is stable or increasing.

7. Information is disseminated to the public through appropriate media.

8. Community Groups are involved in the recovery planning process.

Actions needed

1. Undertake taxonomic studies using allozyme and mitochondrial DNA sequencing, and identify standard morphological characters for use in the field identification of species.

2. Review all information sources and undertake field surveys to identify fully the distribution ranges of the species.

3. Identify natural cave systems within the species' projected distributions (as determined by action 2 above) with the aid of local knowledge, topographic maps and published accounts.

4. Identify the location of early mining operations (now abandoned and in non-mining company tenure) within the species' distributions (as determined by action 2 above) with the aid of local knowledge, topographic maps and published

5. Identify other structures which may form important roost or maternity sites within the distribution ranges (as determined by action 2 above) of the species.

6. Undertake field survey work to confirm the species' presence in roost sites, identified through actions 3, 4, and 5 above, and where the species are found to occur, undertake assessment to determine the nature and immediacy of any threats.

7. Identify the dietary requirements and thermal characteristics of roost sites and the foraging habitat of each species.

8. Analyse survey data and information gathered on dietary requirements, thermal characteristics of roosts and foraging habitat in order to establish priorities for on-ground protection measures of roost and maternity sites.

9. Install bat gates or fences, or develop other protective systems to prevent human disturbance of roost or maternity sites. In some instances the stabilisation of the site may be required to ensure a degree of site longevity and to address human safety concerns. Such work will be done with the collaboration of landholders and/or the appropriate government agency and aboriginal group.

10. Undertake follow-up monitoring at sites where management strategies have been instigated to assess the effectiveness of the above conservation measures. Such monitoring will take into account known or suspected seasonal variation in population size and breeding patterns. Two surveys per year for priority sites is considered a minimum requirement.

11. Provide information releases through local radio and newspaper media to notify the community of project progress and to increase awareness of cave-dwelling bat conservation issues.

12. Hold recovery team meetings every two years and encourage and assist other community groups to join the recovery team.

Estimated costs of recovery

The estimated costs of recovery are shown in Table 2.

Table 2. *Estimated costs of recovery ($'000s/year)*

Action	1	2	3	4	5	6	7	8	9	10	11	12	Total
2001	42	20	3	3	3	49	-	23	55	27	1	1	227
2002	12	25	3	3	3	44	60	12	60	30	1	6	259
2003	-	15	3	3	3	39	20	12	57	27	1	1	181
2004	-	15	3	3	3	39	15	12	57	27	1	6	181
2005	-	-	3	3	3	39	-	12	57	27	1	1	146
Total	54	75	15	15	15	210	95	71	286	138	5	15	994

Biodiversity benefits

The three species of bats considered in this plan are insectivorous and forage over extensive areas and through a range of landscapes and vegetation communities. Their ecological roles in these environments are largely unknown. However, it is

likely that they are important nocturnal insectivores and play a vital role in the maintenance of these communities. Their tendency to congregate in daytime roosts predisposes them to highly localised impacts which may have ramifications over the whole of the populations' foraging range.

The sites used by these species for roosting and maternity are also frequently used by a range of other species. Protection of sites will have the added benefit of conferring security on some of the roost and maternity sites of the species listed in Table 3.

Table 3. *Bat species known to occur at roosts and maternity sites occupied by* Hipposideros semoni*,* Rhinolophus philippinensis *and* Taphozous troughtoni*.*

Species	**Status – *Bat Action Plan***	**Status – *Nature Conservation Act 1992***
Hipposideros cervinus	Lower Risk (least concern)	Vulnerable
Hipposideros stenotis [1]	Data Deficient	Vulnerable
Macroderma gigas	Lower Risk (near threatened)	Vulnerable
Rhinonicteris aurantius [1]	Lower Risk (least concern) [1]	Vulnerable
Taphozous australis	Lower Risk (near threatened)	Vulnerable
Taphozous georgianus	Lower Risk (least concern)	-
Rhinolophus megaphyllus	Lower Risk (least concern)	-
Rhinolophus sp. *maros* form	Data Deficient	-
Miniopterus australis	Lower Risk (least concern)	-
Miniopterus schreibersii orianae	Lower Risk (least concern)	-
Hipposideros ater	Lower Risk (least concern)	-
Hipposideros diadema reginae	Lower Risk (least concern)	-
Vespadelus troughtoni	Lower Risk (least concern)	-
Chalinolobus gouldii	Lower Risk (least concern)	-

[1] These species occur only in the extreme north western portions of Queensland and may not benefit through all of the actions described in this Recovery plan. They may however, occur sympatrically with *T. troughtoni*.

Introduction

Description of Species

Hipposideros semoni - Semon's leaf-nosed bat
H. semoni is a small insectivorous bat with head to body length of approximately 40-50mm and weight of 10-16g. The dorsal pelage colour is normally light grey with a darker grey base whereas the fur on the venter is generally light grey.
Like other species of *Hipposideros*, it has low aspect ratio wings and its flight is relatively slow and manoeuvrable.

Echolocation call frequency varies between the sexes of this species with males producing a constant frequency call of ~94 kHz and females producing a constant frequency call of ~74 kHz. Calls of this species have also been noted in the 83-85kHz band.

Rhinolophus philippinensis - large-eared horseshoe bat
This species is somewhat larger than the more common eastern horseshoe bat *Rhinolophus megaphyllus* and has a head and body length of 60-65mm. It is most easily distinguished from *Rhinolophus megaphyllus* by its large ears (25-35mm). There are two forms of this species currently recognised by Australian bat biologists (Duncan *et al.* 1999), a large form and a smaller form. The larger form is referred to in Duncan *et al.* (1999) as the greater large-eared horseshoe bat and appears to have hugely disproportionate ears, which seem much larger than the head, and the skin of the ears and facial features often exhibit a slight to bright yellow/orange tinge and the fur is often a light fawn colour. This form produces a constant frequency echolocation call of ~28 kHz. It has been allocated a threatened species status of endangered (EN(C2a)) in Duncan *et al.* (1999).

The small form is referred to in Duncan *et al.* (1999) as the lesser large-eared horseshoe bat and lacks the yellowish facial tinge and has fur which is often grey in colour. It has a constant frequency echolocation call of ~40kHz. Duncan *et al.* (1999) allocate this form a status of data deficient (DD).

Taphozous troughtoni - Troughton's sheathtail bat
T. troughtoni is similar in external appearance to *T. georgianus* but averages larger than that species in most skull, dentary, teeth and external characters (Chimimba & Kitchener 1991). Dorsal pelage is olive brown with grey guard hairs while the ventral surface is slightly lighter (Chimimba and Kitchener 1991). The forearm length is 73-76 mm.

No reliable records of this species' echo-location calls exist.

Taxonomy

Hipposideros semoni - Semon's leaf-nosed bat
Although the species level taxonomy of *H. semoni* has generally been considered as stable, some doubt has been expressed recently about its distinction from *H. stenotis* (from western Queensland and the Northern Territory). Although the basis for this doubt rests on morphological similarity, clarification of the distinction is warranted. Also requiring taxonomic investigation is the distinction between the main population of *H. semoni* on Cape York and those allopatric populations to the south, if these southern populations are confirmed to exist.

Rhinolophus philippinensis – large-eared horseshoe bat
Two forms of large rhinolophid are known from far northern Queensland (Churchill, 1998). The taxonomic distinction between these two forms (referred to herein *as R.*

philippinensis and *R*. sp. *maros* form) is confused. There is morphological overlap with north-south clinal variation, and both forms are genetically extremely similar (Cooper *et al.* 1998). Further genetic and cytological analysis followed by morphometrics are required to resolve this long-standing problem.

Taphozous troughtoni - Troughton's sheathtail bat
The distinction between *T. troughtoni* and *T. georgianus* based on results from the Chimimba and Kitchener (1991) study has remained contentious primarily because of the small number of specimens of *T. troughtoni* available for that study. As part of the preparation of this recovery plan, a field trip was undertaken to the Mt Isa region to collect blood samples from *Taphozous* individuals to conduct some initial genetic analysis to indicate whether *T. troughtoni* was distinct from *T. georgianus*. The results from the limited allozyme analysis conducted to date are supportive of the species-level distinction. If these initial genetic typings are correct, then the morphometric boundaries delimited by Chimimba and Kitchener (1991) are not fully supported and need adjustment.

Distribution

Hipposideros semoni - Semon's leaf-nosed bat
The distribution of *H. semoni* extends from Cape York Peninsula to Cooktown although a number of tentative records suggest that it may also occur further south in the Mt. Windsor Tableland area (Coles et al 1996) and Kroombit Tops (Schulz and de Oliveira 1995), or even as far south as St. Mary's State Forest near Maryborough (de Oliveira and Pavey 1995) (Figure 1.)

It also occurs in New Guinea where it has been "recorded on only a few occasions" (Flannery 1995).

Rhinolophus philippinensis - greater large-eared horseshoe bat
The large form of this species has been recorded from the Broken River limestone north west of Townsville to Iron Range on the eastern coast of Cape York Peninsula (Figure 2). The small form has been recorded from a restricted area from the McIlwraith Range to Iron Range on the east coast of Cape York Peninsula.

It has also been recorded in New Guinea, where it is apparently quite rare, and on islands to the north of New Guinea (Borneo, Sulawesi, Philippines, Kai Islands and Timor) (Flannery 1995).

Taphozous troughtoni - Troughton's sheathtail bat.
This species was originally recognised by Tate in 1952 however it was subsequently synonymised with *T. georgianus* and remained in obscurity until 1991 when Chimimba and Kitchener (1991) recognised the taxa as a discrete species and reinstated it as such. Information on distribution is scanty. The type specimen came from a cave near Rifle Creek Dam, 10 miles south of Mt. Isa and other specimens are confirmed from the Native Bee Mine also south of Mt Isa. Several other nearby sites are suspected roosts, including the Ballara railway tunnel south of Mary Kathleen.

Due to the species' taxonomic history, additional specimens may exist in Australian and overseas collections listed as *T. georgianus.*

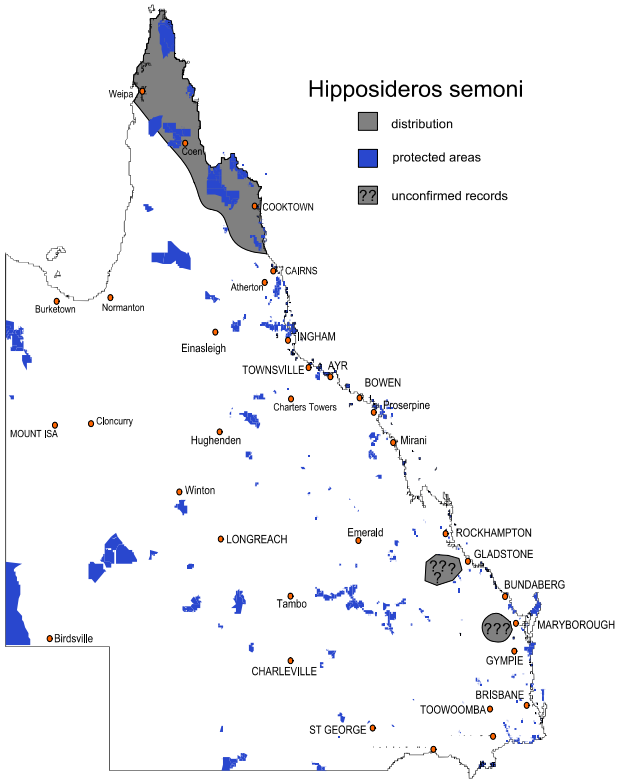

Figure 1. Distribution of Hipposideros semoni

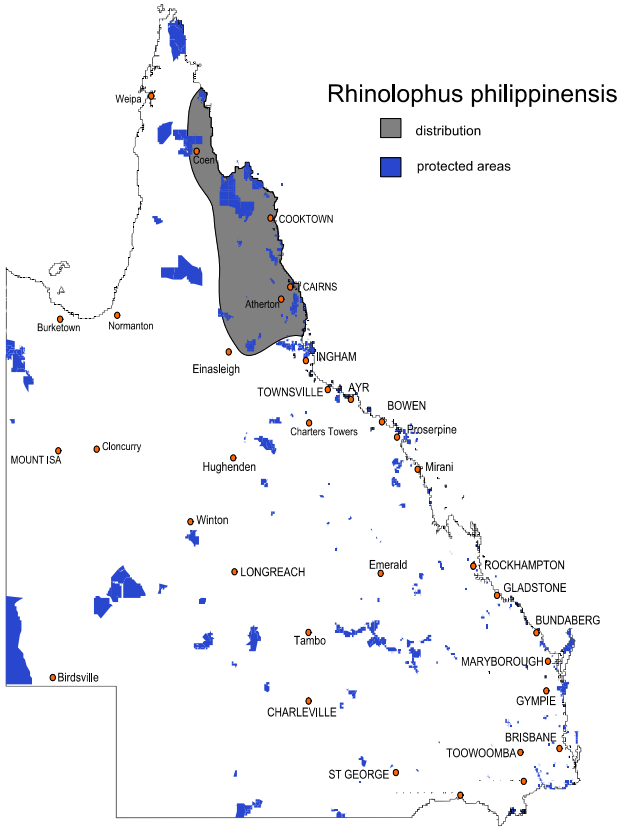

Figure 2. Distribution of Rhinolophus philippinensis

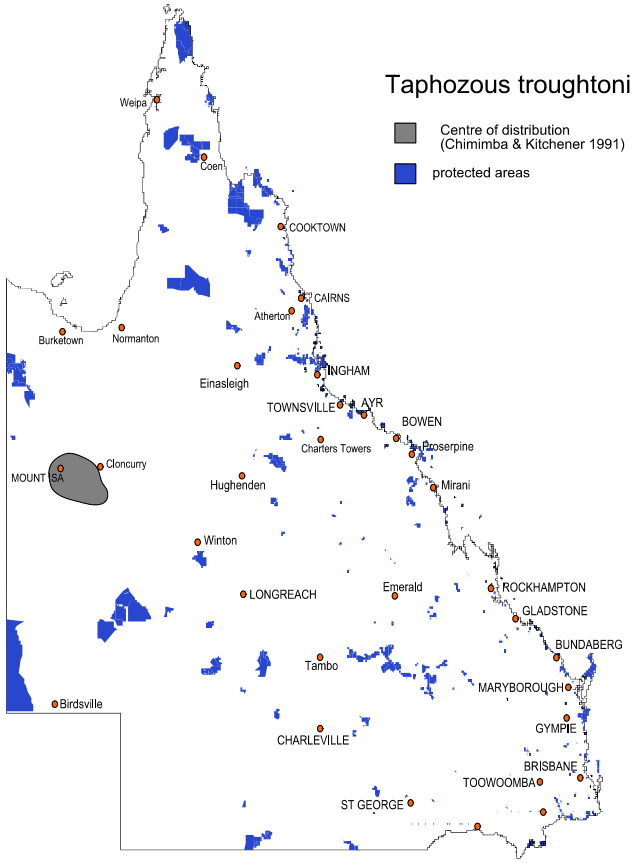

Figure 3. Distribution of Taphozous troughtoni

Habitat and ecology

Hipposideros semoni - Semon's leaf-nosed bat
Very little information is available on the biology of *H. semoni.* However, some researchers believe that it occupies a very similar niche to that of *H. stenotis* which occurs in the northern part of Western Australia, the northern part of the Northern Territory and the Mt Isa region of Queensland.

Both species are typically found in rock escarpment country where they shelter under rock overhangs and in shallow caves, often in twilight or shaded sites rather than in totally dark recesses. In old mines, *H. stenotis* has been recorded often within 5-15 metres of the entrance (Schulz and Menkhorst 1984) and it is thought that *H. semoni* exhibits similar preferences for twilight roost sites.

Maternity sites for *H. semoni* are unknown. However female *H. stenotis* with young attached have been observed in narrow, shallow cave systems. These maternity colonies have been quite small, consisting of from 2-12 individuals (Thomson 1989). It is possible that *H. semoni* forms similar maternity colonies.

Churchill (pers. com.) considers the two species *H. semoni* and *H. stenotis* to be quite ecologically distinct with *H. semoni* being primarily an inhabitant of rainforest and possibly more tree-dwelling in this environment rather than an obligate cave-dweller.

Rhinolophus philippinensis - Large-eared Horseshoe Bat
Throughout its range, *R. philippinensis* has been recorded in caves and mine roost sites where it often co-habits with the more common eastern horseshoe bat *Rhinolophus megaphyllus* (Pavey 1995). It is possible that this species also roosts in the basal hollows of large trees and possibly in dense vegetation (Churchill pers. com.) as does *R. megaphyllus*, although this is yet to be confirmed. Foraging habitat is noted as including rainforest, open eucalypt forest and woodlands; it will also venture into cleared country to feed around electric lights (Pavey 1995). In vegetated habitats the species appears to favour creek lines and other areas where vegetation is thickest (Pavey 1995, Hall and Richards 1979).

Colonies are usually quite small (1-6 individuals) and maternity sites are unknown Duncan et al. (1999).

Taphozous troughtoni - Troughton's Sheathtail Bat.
T. troughtoni is considered to be an obligate cave-dwelling species and similar in many respects to other closely related species, particularly *T. georgianus* which occurs sympatrically in the Mt. Isa region (McKean and Price 1967).
Taphozous is typically a swift, high-flying genus which forages above canopy height.

T. georgianus is often found in the twilight zone of caves and mines but will retreat further into the roost or retreat into an adjacent narrow crevice if disturbed. Substantial fat deposits are accumulated by *T. georgianus* in autumn and larger colonies often disperse over winter and the bats become semi-dormant (Jolly 1995, B. Thomson pers. obs.). For this reason, surveys for *T. troughtoni* may be best carried out during summer months when colonies are more readily detected.
If the species follows a similar annual cycle to *T. georgianus*, young may be encountered in roost sites from November to January.

Reasons for listing

All three species are listed by Duncan *et al.* (1999) in the Commonwealth Action Plan for Australian Bats and are also identified as threatened species in Queensland legislation (Table 1).

It is expected that these species will soon be listed in the Schedules of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth). It is anticipated that the status of *H. semoni* and *R. philippinensis* will remain as described in *The Action Plan for Australian Bats* whereas the status of *T. troughtoni* may be downgraded to vulnerable following studies that were undertaken during the development of this recovery plan.

For these species, roost/maternity site destruction is listed as a predominant threat. *R. philippinensis* was known from a number of roost sites in abandoned mines, some of which were destroyed when old adits were closed during site remediation. A considerable number of abandoned mine sites currently exist in far northern Queensland which have never been surveyed and may be subject to safety closures in the future.

As tourism pressures increase, the number of natural cave systems being explored, and the frequency of visitation to the more accessible sites, is also increasing. It is thought that this may be placing pressure on cave bat populations in certain areas.

Hipposideros semoni is considered to have declined. This conclusion is based on a comparison of historic and current collection records for the species. *The Action Plan for Australian Bats* indicates that causal factors are difficult to identify but that destruction of roosts and frequent disturbance may be contributing factors.

Taphozous troughtoni is a very poorly known species with apparently quite restricted distribution. Many of its roost sites, including that at the type locality, have been destroyed and so the only confirmed threat listed in the Action Plan for Australian Bats is roost destruction.

Recovery objectives listed in the Action Plan for Australian Bats for these species relate predominantly to the identification and protection of roost and maternity sites. However, several other actions are also recommended in the Action Plan. These include:

- taxonomic studies to clearly distinguish closely related species (*Taphozous troughtoni/T. georgianus*);
- taxonomic studies to clearly delineate the two forms of *R. philippinensis* which have recently been shown to be genetically distinct (Cooper et al. 1998);
- taxonomic studies of populations of *H. semoni* to determine appropriate conservation units and to distinguish the species from *Hipposideros stenotis*; and
- further survey work to identify the distributional limits of *T. troughtoni* and *H. semoni.*

Existing conservation measures

Rhinolophus philippinensis and *Hipposideros semoni* occur in the Wet Tropics World Heritage Area and are therefore afforded a level of habitat protection. These species have also been recorded in a number of protected areas in Queensland (Table 4).

Table 4. *List of protected areas within Queensland with reported occurences of* Rhinolophus philippinensis, Hipposideros semoni and Taphozous troughtoni*.*

Species	**Protected Area (ha.)**
Rhinolophus philippinensis	Black Mountain National Park (903) Daintree National Park (76,000) Paluma Range National Park (10,700) Iron Range National Park (34,600) Mungan Kandju National Park (457,000) Cape Melville National Park (36,000) Starcke National Park (7960) Chillagoe-Mungana Caves National Park (3690) Undara Volcanic National Park (61,500)
Hipposideros semoni	Iron Range National Park (34,600) Black Mountain National Park (903) Starcke National Park (7960) Cape Melville National Park. (36,000)
Taphozous troughtoni	None known

The Queensland Parks and Wildlife Service, through the protected area management planning process, is continuing to develop specific management guidelines for the conservation of sites of particular conservation value on its protected area estate. Similarly, the Queensland Department of Natural Resources has developed guidelines for the protection of such sites under State Forest tenure. It is envisaged that the management strategies developed through this plan will be incorporated into the operational plans of these and other relevant land management agencies.

Queensland Parks and Wildlife Service and Queensland Department of Mines and Energy have commenced planning a conservation program to identify and protect roost sites for cave-dwelling bats throughout the state on a range of tenures. It is envisaged that this initiative will complement the works proposed in this recovery plan and provide substantial in-kind contributions to the recovery program.

Recovery objectives and criteria

Overall objectives

- To clarify the taxonomic status of the subject species.

- To ensure that priority roost and maternity sites throughout the species' distributions are protected from identified threats.

- To document aspects of species ecology necessary for effective species management and conservation.

These actions should significantly improve the conservation status of the species.

Specific objectives during the life of the current recovery plan

1. To establish the status of poorly known species and to identify appropriate species management units within two years of implementation of the plan (required for objective 3).

2. To gather the necessary biological data from current records and through new, targeted field work for the effective conservation management of the species.

3. To implement conservation strategies or on-ground conservation works in priority sites where the species occur. These initiatives will be designed to mitigate identified threatening processes.

4. To identify trends in the species' abundance at priority sites across their distributional ranges after the instigation of conservation strategies or on-ground conservation works.

5. To encourage community participation in and understanding of the recovery process and the conservation issues related specifically to cave-dwelling bats.

Recovery criteria

1. All species are taxonomically delineated.

2. Species' distribution ranges are identified.

3. Roost and maternity sites for species are identified and prioritised.

4. Species' roost site characteristics, diet and habitat use are identified.

5. On-ground works are completed, or agreed conservation management practices implemented at priority roost and maternity sites.

6. At sites where on-ground management practices or works have been implemented, follow-up surveys indicate that population size is stable or increasing.

7. Information is disseminated to the public through appropriate media.

8. Community Groups are involved in the recovery planning process.

Actions needed

1. Undertake taxonomic studies using allozyme and mitochondrial DNA sequencing, and identify standard morphological characters for use in the field identification of species.

2. Review all information sources and undertake field surveys to identify fully the distribution ranges of the species.

3. Identify natural cave systems within the species' projected distributions (as determined by action 2 above) with the aid of local knowledge, topographic maps and published accounts.

4. Identify the location of early mining operations (now abandoned and in non-mining company tenure) within the species' distributions (as determined by action 2 above) with the aid of local knowledge, topographic maps and published accounts, and locate potential mine sites which may be roost and/or maternity sites.

5. Identify other structures which may form important roost or maternity sites within the distribution ranges (as determined by action 2 above) of the species.

6. Undertake field survey work to confirm the species' presence in roost sites, identified through actions 3, 4, and 5 above, and where the species are found to occur, undertake assessment to determine the nature and immediacy of any threats.

7. Identify the dietary requirements and thermal characteristics of roost sites and the foraging habitat of each species.

8. Analyse survey data and information gathered on dietary requirements, thermal characteristics of roosts and foraging habitat in order to establish priorities for on-ground protection measures of roost and maternity sites.

9. Install bat gates or fences, or develop other protective systems to prevent human disturbance of roost or maternity sites. In some instances the stabilisation of the site may be required to ensure a degree of site longevity and to address human safety concerns. Such work will be done with the collaboration of landholders and/or the appropriate government agency and aboriginal group.

10. Undertake follow-up monitoring at sites where management strategies have been instigated to assess the effectiveness of the above conservation measures. Such monitoring will take into account known or suspected seasonal variation in population size and breeding patterns. Two surveys per year for priority sites is considered a minimum requirement.

11. Provide information releases through local radio and newspaper media to notify the community of project progress and to increase awareness of cave-dwelling bat conservation issues.

12. Hold recovery team meetings every two years and encourage and assist other community groups to join the recovery team.

Table 5. Relationship between specific objectives, recovery criteria and actions.

Specific Objectives	Recovery Criteria	Actions
1. Clarify the taxonomic status of the taxa and identify appropriate management units or species.	1. All species are taxonomically delineated.	1. Undertake taxonomic studies.
2. Gather biological data required for conservation management.	2. Distributional ranges are identified. 3. Roost and maternity sites are identified and prioritised. 4. Site characteristics, species' diet and habitat use are identified.	2. Undertake review of information and targeted surveys for species. 3. Identify natural cave. systems that require survey. 4. Locate and map abandoned mines that require survey. 5. Locate other roost structures that require survey. 6. Undertake field surveys to assess possible roost/ maternity sites. 7. Identify dietary requirements and other ecological factors. 8. Analyse survey data and other information. 9. Prioritise sites for on-ground conservation management work.
3. Implement conservation management strategies at priority sites.	5. On-ground works completed or agreed conservation management practices implemented at priority sites.	9. Install bat gates and carry out other management as required to protect sites in collaboration with relevant stakeholders.
4. Identify trends in species abundance at priority sites following implementation of conservation management strategies or on-ground conservation works.	6. Follow-up surveys at sites where on-ground management practices have been implemented indicate increase in populations or stable population trends.	10. Undertake follow-up monitoring work at sites where management strategies have been instigated.
5. Encourage community participation in and understanding of cave bat conservation issues.	7. Information is disseminated to the public through appropriate media. 8. Community groups are involved in the recovery planning process.	11. Provide information through local radio and newspaper media to advise progress and to increase awareness. 12. Hold recovery team meetings every two years, and less formal communication on a more regular basis. Encourage and assist other community groups to join the recovery team.

Recovery Actions

Action 1

Taxonomic studies will be undertaken to confirm the status of species and determine conservation units for species listed in the recovery plan.

Aims

The taxonomic status of all three species requires further examination to determine appropriate conservation units for further management actions.

Relationship to other recovery actions

Determines priorities and links to actions 3-6. This action can not proceed without the samples collected in action 2.

Justification

Since its original publication by Tate in 1952, the specific epithet *Taphozous troughtoni* has been variously recognised at subspecific level (McKean and Price 1967, Koopman 1984) or upheld as a good species (Chimimba and Kitchener 1991). The taxon is evaluated by Duncan *et al.* (1999) as a valid species and is classified as critically endangered (B1, B2c). It is envisaged however, that this status would require immediate revision if it was determined through further research to be synonymous with the other species commonly occurring in the area, *T. georgianus*. Preliminary taxonomic work, conducted as part of the development of this recovery plan has indicated that *T. troughtoni* is distinct from *T. georgianus* but further DNA and morphometric analysis is required. Further work is also required to explore more fully its taxonomic relationships with other members of the genus. An important aspect of this taxonomic study will be the development of reliable keys to identify specimens in the field.

Hipposideros semoni is classified as endangered (EN (C2a, D)) by Duncan *et al.* (1999). Some researchers have expressed the opinion that this species appears to be very similar to *H. stenotis* in both its physical appearance and ecology, and have indicated that the relationship between these species should be examined further. Survey results for *H. semoni* also tentatively indicate that the species may exist in two geographically discrete areas. If this proves to be correct, then a taxonomic assessment of both populations will be required in order to determine their relationship. Studies of both the relationship between *H. semoni* and *H. stenotis*, and of the two populations of *H. semoni* may have considerable bearing upon any future assessment of their conservation status.

Rhinolophus philippinensis is also classified as endangered (EN (C2a)) by Duncan *et al.* (1999). Shortly before this status was determined, genetic studies revealed that a smaller taxon, *R.* sp. *maros* form, found in the Iron and McIlwraith Ranges, and which had traditionally been confused with *R. philippinensis*, is genetically distinct (Cooper *et al.* 1998). This taxon appears in Duncan *et al.* (1999) under the same specific epithet as the larger species but insufficient information exists to determine a status for it. Further taxonomic studies are required to resolve the level of taxonomic difference between these two forms and to develop reliable field keys to distinguish between them.

Methods

In the first year of the plan, the aim will be to resolve species boundaries and identify intra-species conservation units or evolutionary significant units. The methods used will vary according to the species. For *H. semoni* and *T. troughtoni* it is proposed that

a combination of allozyme analysis, mitochondrial DNA sequencing and morphometric analysis be used. The *R. philippinensis* problem is more complex because the *R.* sp*. maros* form may prove to be a hybrid between *R. philippinensis* and *R. megaphyllus*. The work of Cooper *et al.* (1998) suggests that to resolve the problems in *R. philippinensis*, a combination of both microsatellite and mitochondrial DNA sequencing is required. It is also proposed to investigate whether the morphological variation is a result of chromosomal evolution.

In the second year, it is proposed that further genetic work will be required if intra-species structuring is evident and if the number of specimens available in the first year is limiting. More targeted collecting may be required, especially in *Taphozous* to relate genotypes to morphology.

Tissue sampling will be done without sacrificing animals. Blood samples will be used in the allozyme work and hair and small wing membrane samples will be used for DNA sequencing. Use will also be made of preserved specimens in museums.

In subsequent years it may be important to examine population structures of these threatened taxa using genetic techniques.

Responsibilities
Administration: QPWS. Taxonomic Assessment: SA Museum

Costs
Action 1 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	42	12	-	-	-	54

Action 2

Undertake a review of all information sources and conduct targeted surveys to fully establish the distribution ranges of *Taphozous troughtoni* in the Mt. Isa region and *Hipposideros semoni* in central Queensland. Some field work will also be required in the Iron Range and McIlwraith Ranges to establish the range of *Rhinolophus* sp*. maros* form.

Aims
To establish the distribution ranges of all species listed in the plan so that targeted conservation works at roost and maternity sites can be directed to all relevant areas.

Relationship to other recovery actions
Determines areas to be assessed in actions 3, 4 and 5. This action also directly contributes to action 6 since field surveys will provide assessment information for some areas as described in action 6.

Tissue sampling will be undertaken for action 1.

Justification
Taphozous troughtoni is known from the Mt Isa region where it has been collected at only a small number of localities. All of these sites have been within the Mt Isa Inlier biogeographic region which extends from the Mt Isa area, north-west towards the Gulf of Carpentaria. Further work is required to survey the northern parts of this biogeographic region to establish the full extent of the distribution of this species.

Hipposideros semoni is thought to occur in the Mt Windsor Tablelands in north Queensland and Kroombit Tops and St. Mary's State Forest areas in central eastern Queensland. However, the species has not been confirmed from these areas. If found in these areas, conservation management objectives may need to be reassessed and a program developed to address specific threatening processes.

Rhinolophus sp*. maros* form is known from the McIlwraith and Iron Range areas. However the species with which it is most closely affiliated (*R. philippinensis*) has a more extensive distribution. The reasons why the *R.* sp*. maros* form has such a relatively restricted distribution are unknown and further work is required on Cape York to establish fully its distribution.

The survey activity described here differs from that proposed in actions 3, 4 and 5 since this work is specifically directed towards the establishment of species' distribution and proposes to examine localities where these species may exist but have not been confirmed. In the following actions, data collection and survey are only undertaken within known distribution ranges, as determined through this action.

Methods
Targeted survey work will be undertaken using standard bat collecting techniques in the areas listed above.

Responsibilities
Administration: QPWS. Survey work and data analysis: QPWS, DNR and contractors as required.

Costs
Action 2 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	20	25	15	15	-	75

Action 3
Collate existing locality records and identify natural cave systems within the species' projected distribution ranges. Identify potential sites which may be of roost/maternity significance.

Aims
To collate all existing locality records for the species and to locate other specific sites or geological formations which may require surveying. This baseline data will (i) provide as complete an understanding as possible of the current distributional range of the species in natural cave systems; and (ii) identify areas where natural cave systems exist that require further survey work and assessment.

Relationship to other recovery actions
Identifies specific locations for survey work proposed in action 6. Also relates to action 1.

Justification
The information gathered will be used as a basis for the field survey work (action 6). It is strongly suspected that a number of specimens of these taxa are held in various collections but are either mis-identified or not identified at all. Much of the cost shown here represents travel and accommodation expenses to examine many of the key collections held in Australia to sort specimens and to obtain such distribution data

which would otherwise not be available. Specimens stored in spirits may be suitable for the taxonomic work described in action 1 and will be utilised where ever possible.

Methods
Information will be gathered from a range of sources including museum specimens, local knowledge, geological and topographic maps and other published accounts. The information obtained will be collated and survey strategies will be developed accordingly.

Responsibilities
Administration: QPWS. Museum investigations*:* QPWS. Other data gathering and development of survey strategies*:* Central Queensland Speleological Society.

Costs
Action 3 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	3	3	3	3	3	15

Action 4

Map the location of early mining operations (now abandoned and often non-mining company tenure) within the species' projected distributional range to identify potential mine sites which may be of roost and/or maternity significance.

Aims
To collate all existing records of historic mine sites which may require surveying. This baseline data will facilitate the identification of abandoned mining areas which require further survey field work and assessment for the subject species.

Relationship to other recovery actions
Identifies specific locations for survey work proposed in action 6.

Justification
The information gathered will be used as a basis for the field survey work (action 6 below).

Methods
Information will be gathered from a range of sources including museum specimens, mine records, local knowledge, geological and topographic maps and other published accounts. The information obtained will be collated and survey strategies developed accordingly.

Responsibilities
Administration*:* QPWS. Data gathering and development of survey strategies*:* consultants.

Costs
Action 4 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	3	3	3	3	3	15

Action 5

Identify other structures which may be important roosts or maternity sites.

Aims
To ensure that other important roost and maternity sites in tunnels, pipes, old buildings and similar structures are identified and assessed for conservation management.

Relationship to other recovery actions
Identifies specific locations for survey work proposed in action 6.

Justification
Buildings and other man-made structures often provide suitable roosting and maternity habitat for cave-dwelling bats. Populations in these sites are often quite large and their disturbance or destruction may directly contribute to the decline of these species' populations and current distributions. They have been included for survey and possible conservation management attention for this reason.

Methods
Information will be gathered from a range of sources including museum specimens, local knowledge and other published accounts. The information obtained will be collated and survey strategies developed accordingly.

Responsibilities
Administration: QPWS. Data gathering and development of survey strategies: recovery team members as appropriate.

Costs
Action 5 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	3	3	3	3	3	15

Action 6

Conduct field survey work to confirm the species' presence in potential roost or maternity sites as identified through actions 3, 4 or 5 above. At sites where the species are found, numbers, reproductive activity, structural stability of the site, degree of human disturbance and other threatening processes will be assessed.

Aims
To gather field information for important roost and maternity sites, to identify threats and to prioritise sites for conservation management actions in order to reduce these threats.

Relationship to other recovery actions
Data from actions 3, 4 and 5 are used to identify areas to be surveyed in this proposed action. During this survey work information will be collected which is then assessed in action 8. Sites for further study as proposed in action 7 are also identified.

Justification
Many potential roost and maternity sites exist within the distribution range of the species. It is envisaged that most, if not all, of these sites will be mapped through actions 3, 4 and 5 above. Sites will need to be surveyed in order to determine if the species occur there, the stability of the site and the nature and immediacy of any threats. This work will be required before effective site-specific conservation

management strategies can be developed. The ecological work proposed in action 7 will be conducted at those sites with significant populations of threatened species, and so this survey work will provide the necessary basis to develop a detailed strategy for action 7.

Methods
Survey work will be carried out in the dry seasons (less critical for the Mt Isa Inlier biogeographical region) with access to the sites gained by four wheel drive vehicle or walking. Each cave, mine or bat roost structure will be surveyed to determine the species present, the size of populations and the usage of the site at the time of the visit (e.g. maternity), the stability of the site, and the nature of threats which may exist. Particular note shall be made of human visitation to the sites and the future potential for human disturbance.

Species surveys will be conducted at the entrances to sites using either ultrasound analysis or capture. The recovery team will recommend that no persons enter potentially dangerous abandoned mines or other structures to search for bats during survey work.

A standardised proforma will be used by all survey teams to record the data.

Responsibilities
Administration: QPWS Survey work: QPWS, Central Queensland Speleological Society, recovery team members and consultants as appropriate.

Costs
Action 6 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	49	44	39	39	39	210

Action 7
Identify the dietary requirements and thermal characteristics of high priority roost and maternity sites, and foraging habitat of each species.

Aims
To gather information on the above habitat attributes and micro-environments as a basis for further conservation management. The information will ensure that management actions meet the requirements of the species. It will also enable a holistic approach to be taken to ensure conservation of all environment elements required for the species' survival.

Relationship to other recovery actions
Information from this action will enable the development of appropriate conservation management strategies to be implemented in action 9.

Justification
Diet
Although a small study of the diet of *R. philippinensis* has been completed (Pavey 1999), nothing is known of the diet of the other two species. This information will be valuable as it might explain the rarity of either species and could identify habitat requirements that will need to be accommodated within conservation management strategies.

Roost microclimate
Roost and maternity sites, which are located in natural cave systems and old mines, are a key resource for each of the species. These sites can experience a high level of disturbance or destruction caused by human visitation, deliberate closure or collapse of mines, and mining activity. Duncan *et al*. (1999) list roost/maternity site destruction as a predominant threatening process for all three species. A number of conservation management strategies including gating of roost entrances are available to alleviate the impacts of disturbance. However, in some cases gating has also caused negative impacts to bat colonies (e.g. Richter et al. 1993). Currently it is unknown what type of roost microclimate is chosen by any of the species and whether microclimate requirements differ between maternity and non-breeding sites. This information is essential so that managers can: a) determine whether a particular disturbance regime will significantly change the microclimate and thus the suitability of a roost; and b) ensure that management strategies such as gating do not adversely alter conditions within a roost.

Foraging environment
Foraging habitat is a critical resource that must be available for each species to persist in an area. Currently, information on foraging habitat is available for a small sample of *R. philippinensis* (Pavey 1999). However, the habitat described in this study is unlikely to be typical of the species. Information on habitat requirements of each species is essential so that management strategies can ensure that sufficient suitable habitat is available in the vicinity of high priority roost sites.

Some anecdotal information suggests that *H. semoni* and *R. philippinensis* may roost away from caves and mines, perhaps on a regular basis (Churchill 1998). Other species of Australian *Hipposideros* are known to roost in hollow trees (e.g. *H. ater*) or in the canopy of rainforest (e.g. *H. diadema*). If either of the target species roosts away from traditional subterranean sites this could explain why they are rarely encountered and why there is a seasonal bias in records of *R. philippinensis* at some sites such as Chillagoe. Further, *T. troughtoni* may roost in rock crevices or fissures away from large caves or mines. Location of such roosts will allow a more accurate assessment of the population size of each species.

Methods
Diet
Faecal samples will be collected from known individuals of each species during the course of other activities. The aim is to examine 100-150 faecal pellets of each species using samples from at least 10 individuals of each species. Samples will be air-dried at the collection site, stored in glass vials and transported to Brisbane for analysis. In the laboratory, each pellet will be placed in a petri dish and 4-5 drops of 10% KOH added directly to it. The pellet will be teased apart within 2-3min and then covered in 70% ethanol. Each pellet is then systematically searched for identifiable material under a low power (6.4-40 $\times$) binocular microscope. Prey items will be identified to the lowest taxonomic level possible. This methodology is a modified version of that developed for other Australian hipposiderid and rhinolophid species (e.g. Pavey and Burwell 2000).

Roost microclimate
Information on roost microclimate will be collected once high priority roost and maternity sites have been identified. Four high priority roosts (two maternity, two non-breeding sites) will be selected for each species. In cases where less than four high priority roosts are identified, all roosts will be used. Microclimate data will be collected by placing data loggers in roosts as close as possible to the actual roosting positions of the target species. Data loggers will be left in roosts for periods of about two

months in both summer and winter. Data will be dumped from the loggers to a personal computer on a regular (fortnightly or monthly) basis. Variables measured by the data loggers will include:

- mean night-time and day-time temperature and relative humidity,
- daily maximum and minimum temperature and relative humidity,
- temperature and relative humidity ranges, and
- day-time light intensity.

Data obtained using these methods will be collated and summarised to provide an assessment of the thermal characteristics of high priority maternity and non-breeding roosts of each of the study species. This information will form the baseline data upon which management decisions regarding disturbance to or modification of roosts are based.

Foraging environment

Lightweight radio tags (weight of tags must be <5% of the body mass) will be attached to the dorsal surface of a sample of individuals of each species. Bats will be tracked using receivers and antennae. It is planned to continue tracking until a sample of about 10 individuals of each species is tracked for a minimum of 4-5 nights each.

It is probable that the method of tracking will differ between species because some will move greater distances than others. *H. semoni* and *R. philippinensis* are likely to have relatively small home ranges. A combination of a mobile observer (on foot or vehicle based) and a stationary observer on a suitable high point (e.g. hill or tower) is usually the best method to track such species. The observation team will attempt to track continuously a target bat for the duration of the night. If contact with a target bat is lost or if it begins to roost, observers will then attempt to track another individual. The exact location of bats will be determined by the 'homing-in' method in which an observer gradually moves closer to the source of the signal until relatively sure that the exact location of the transmitter has been pin-pointed (Pavey 1998). Observers will keep in contact using two way radios. Location of foraging areas will be mapped on a nightly basis. Day-time inspections of foraging areas will be carried out to determine the vegetation type, degree of disturbance and special habitat features (e.g. presence of water bodies) of foraging areas.

In contrast to the other species, *T. troughtoni* will probably have a large home range because it is very likely to be a fast flier that hunts in open space. The best method for tracking such a species is by triangulation of the location of tagged bats by three observers in stationary positions on suitable high points taking fixes at regular intervals (probably every 15 minutes) (e.g. Tidemann *et al*. 1985). The triangulation method enables a large number of bats to be tracked simultaneously. Bats will be tracked from dusk until dawn each night. Foraging ranges will need to be mapped using specialist software such as Ranges 5. Subsequently, foraging areas can be superimposed on topographic maps and vegetation examined in detail using aerial photographs.

Observers will attempt to track bats to their roosts at dawn or to locate the source of signals from roosting bats during day-time. Although it is likely that most individuals will return to the roosts in which they were captured, many bat species regularly move roosts (e.g. Pavey 1998). By tracking bats to their roosts each day, it will be possible to determine the full range of roost types occupied by each species.

Responsibilities
Administration: QPWS. Field work and data collation: recovery team members and consultants as appropriate. Diet assessment and reporting: Dr Chris Burwell, Curator – Higher Entomology, Queensland Museum.

Costs
Action 7 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	-	60	20	15	-	95

Action 8
Analysis of survey data and ecological information in order to assess the nature of threatening processes and to establish priorities for on-ground protection measures of roost and maternity sites.

Aims
To create a permanent record of surveyed sites, determine species distributions and abundance over the extent of their surveyed geographical range and to prioritise sites for on-ground conservation measures. Data collected during the initial survey will also be used on a comparative basis for future monitoring.

Relationship to other recovery actions
Synthesises data collected through action 6 and determines priorities for action 9.

Justification
This action collates data that was obtained through the field surveys and is required so that a program of on-ground conservation actions can be developed. Data gathered through the surveys will also assist in the delimitation of species distributions and abundance.

Methods
Data will be entered into a database compatible with the departmental WildNet database. Sites will be prioritised according to their relative importance for the species concerned, the degree and nature of identified threats and their stability. Thus highest priority will be assigned to those sites with the greatest number of rare and threatened species or largest populations of a single threatened species, where there is a considerable risk of disturbance (or under most severe threat) and which are most stable. Lowest priority will be assigned to those sites with very few or no individuals, where there is no immediate risk of disturbance (or threat) and which are unstable, and thus possibly of short term benefit to the populations.

Responsibilities
Database management and data analysis*:* QPWS.

Costs
Action 8 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	23	12	12	12	12	71

Action 9

Install bat gates, fences or develop other appropriate protective systems to prevent human disturbance of roost and maternity sites or to mitigate other identified threats.

Aims

To conserve high priority roost and maternity sites for the species and thus to maintain or improve the species current distribution range and abundance.

Relationship to other recovery actions

Necessary follow-on from actions 2-8. Work undertaken is then monitored in action 10.

Justification

The instigation of site-specific conservation management programs will be required to reduce identified threats at many sites which are of conservation significance to the species.

Methods

The development of appropriate conservation management programs will require liaison with the relevant land management agency or landholder. On-ground actions may include the erection of bat gates or the implementation of other measures to prevent or regulate human access to roost and maternity sites, or to address other identified threatening processes.

Management strategies developed for sites on State Government lands will be developed to complement existing planning initiatives as required by the relevant departments.

Sites which are unstable and which contain significant populations of threatened species may be stabilised with suitable structures at the entrance (since in the case of mines, instability is most commonly encountered at the entrance where the portal is constructed in soil or weathered rock material). These sites should then be protected from human visitation.

Responsibilities

On-ground works: members of the recovery team as appropriate, landholders and aboriginal traditional owners.

Costs

Action 9 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	55	60	57	57	57	286

Action 10

Follow-up survey work and monitoring at sites where management strategies have been instigated.

Aims

To evaluate the effectiveness of on-ground works or other conservation measures at priority roosts and maternity sites to ensure that they are effectively protecting the sites and providing suitable long-term habitat for threatened bats.

Relationship to Other Recovery Actions
Monitoring required as a result of undertaking action 9 and to check progress towards achievement of the project's major conservation objective (overall objective 1).

Justification
Conservation measures used at any site will necessarily be site-specific and monitoring of sites will be required to ensure that conservation measures are working effectively. Many sites are subject to seasonal usage by various species and it will be important to ensure that no bat species are disadvantaged, disturbed or prevented from gaining access to the site as a result of on-ground works.

Methods
Sites will be accessed by vehicle or on foot, either specifically to conduct follow-up surveys, or opportunistically as members of the recovery team engage in other management activities in the area. The proforma used in the original site inspections (action 6) will be used in the monitoring program and will be entered into the same database.

Any negative trends at sites where conservation works have been carried out will be investigated, and if necessary, changes will be made to address any problems that are identified.

Responsibilities
Site monitoring*:* recovery team members as appropriate. Data entry and analysis*:* QPWS. Remedial works*:* recovery team members as appropriate.

Costs
Action 10 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	27	30	27	27	27	138

Action 11
Provide information releases through local radio and newspaper media to notify the community of project progress and to increase awareness of cave-dwelling bat conservation issues.

Aims
To increase public awareness of cave and abandoned mine conservation issues.

To gather information from the general public on the location of local bat roosts in caves and abandoned mines.

Relationship to other recovery actions
Information received from the public will link directly to actions 3, 4 and 5. The involvement of the community will be important to ensure the success of action 9 and 10.

Justification
The major threatening process for roost and maternity sites, as identified in *The Action Plan for Australian Bats*, is visitation and disturbance by the public. It will be most important therefore, to educate local communities and to promote the measures which have been implemented through action 9, in order to gain community support. Local communities also have knowledge of the location of old mines and natural

caves in their areas, and means of access to them. This information is invaluable and would supplement other data gathered through actions 3, 4 and 5.

Methods
The recovery team will prepare news releases and provide interviews to the media as appropriate.

Responsibilities
Production of media materials: recovery team members as appropriate.

Costs
Action 11 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	1	1	1	1	1	5

Action 12
Hold recovery team meetings every two years and encourage and assist other community groups to join the recovery team.

Aims
To involve all stakeholders in the recovery actions. To ensure a high degree ownership of the project by local communities so that conservation goals are promoted in the long term through cooperation and understanding. To gain the necessary community group and government agency support and approvals to ensure project success.

Relationship to other recovery actions
Provides coordination and direction for the implementation for all other actions listed in the plan. Links to action 11.

Justification
Conservation management strategies for roosts and maternity sites will be implemented across a range of tenures, and so it will be important to ensure that the relevant management agencies are able to implement these strategies through the development of appropriate, agency-specific operational policies and guidelines.

The recovery team has a diverse membership, with a number of members interested in specific aspects of the recovery process. For example, Queensland Department of Mines and Energy is concerned wholly with the rehabilitation of mine sites and other structures on mining leases whereas the Central Queensland Speleological Society and the Chillagoe Caving Club are concerned primarily with the conservation of natural cave systems. A list of recovery team members and their interests are presented below. The recovery team brings these members together to achieve the agreed conservation outcomes in this plan.

Local community groups provide an invaluable source of expertise.

Recovery Team Member	Interests
Queensland Department of Mines and Energy	Mine site rehabilitation (both current and abandoned mining operations)
Queensland Department of Natural	Conservation issues on State Forests and

Resources	other DNR tenure lands
Australasian Bat Society	Survey to establish the distributional limits of *Taphozous troughtoni*
Central Queensland Speleological Society	Survey of natural cave systems for threatened bat species
Chillagoe Caving Club	Survey of natural cave systems for threatened bat species
South Australian Museum	Taxonomic studies
Queensland Parks and Wildlife Service	Conservation of threatened species/project coordination
Phoniscus Consultants	Bat gate construction

Methods
In the development of this plan, liaison has been carried out with individual members or groups of members to address aspects of the project which are of specific concern to them. It is anticipated that this approach will be maintained to reduce costs. However, full meetings of the recovery team will be convened every two years to plan and coordinate activities.

A number of community groups are currently members of the recovery team. Other groups will be approached and encouraged to participate.

Responsibilities
Meeting convenor: QPWS. Liaison: QPWS and other recovery team members as appropriate.

Costs
Action 12 costs ($ 000's)

Year	Yr1	Yr2	Yr3	Yr4	Yr5	Total
Costs	1	6	1	6	1	15

Implementation schedule

Table 6. Annual costs and priority for each action.

Action	Action Description	Priority	Feasibility	Expense type	Cost Estimates ($000s/year)				
					Yr1	Yr2	Yr3	Yr4	Yr5
1	Taxonomic work	1	100%	salaries consumables	5 37	5 7			
2	Establish distributions	2	80%	salaries travel	6 14	7.5 17.5	4.5 10.5	4.5 10.5	
3	Identify potential caves for survey	2	90%	salaries	3	3	3	3	3
4	Identify potential mines for survey	2	90%	salaries	3	3	3	3	3
5	Identify other sites for survey	3	80%	salaries	3	3	3	3	3
6	Field survey	2	90%	salaries travel	14.7 34.3	13.2 30.8	11.7 27.3	11.7 27.3	11.7 27.3
7	Identify diets, roost microclimate and foraging habitat	3	90%	salaries travel equipment		39 12 9	12 8	9 6	
8	Data analysis	2	100%	salaries	23	12	12	12	12
9	On-ground conservation works	1	80%	salaries travel materials	33 11 11	36 12 12	34.2 11.4 11.4	34.2 11.4 11.4	34.2 11.4 11.4
10	Follow-up monitoring	2	90%	salaries travel	8.1 18.9	9 21	8.1 18.9	8.1 18.9	8.1 18.9
11	Inform the community	1	90%	salaries materials	.5 .5	.5 .5	.5 .5	.5 .5	.5 .5
12	Recovery team meetings	1	80%	salaries travel	1	1 5	1	1 5	1

Acknowledgments

The recovery team wish to thank Sue Churchill for her invaluable comments and for making available data from her survey trips in northern Queensland.

We would also like to thank Noleen Kunst (QPWS) for her comments on the manuscript and Greg Gordon for his editorial skills in finalising the plan.

References

Chimimba, C.T. and Kitchener, D.J. 1991. A systematic revision of Australian *Emballonuridae* (Mammalia: Chiroptera). *Records of the Western Australian Museum* 15, 203-265.

Churchill, S. 1998. *Australian Bats*. Reed New Holland, Sydney. 230pp.

Coles, R.B., Clague C.I., Spencer H. and Whybird, O. 1996. Bat survey and the 'priority' species in the Wet Tropics World Heritage Area of Australia. *7th Australasian Bat Conference Abstracts.* Australasian Bat Society, Naracoorte.

Cooper, S.J.B., Reardon, T.B. and Skillins, J. 1998. Molecular systematics of Australasian rhinolophid bats (Chiroptera: Rhinolophidae). *Australian Journal of Zoology* 46, 203-220.

de Oliveira, M.C. and Pavey C.R. 1995. In search of *Hipposideros semoni* at St. Mary's State Forest, north-east Queensland. *Australasian Bat Society News* 4, 46-48.

Duncan, A., Baker, G.B. and Montgomery, N. (eds) 1999. *The Action Plan for Australian Bats*. Environment Australia, Canberra.

Flannery, T.F. 1995. *Mammals of New Guinea*. Reed Books, Chatswood, NSW.

Hall, L.S. 1995. Semon's Leaf-nosed Bat, *Hipposideros semoni*. Pp. 461-462 *in* R. Strahan (ed.) *The Mammals of Australia*. Reed Books, Chatswood.

Hall, L.S. & Richards, G.C. 1979. *Bats of Eastern Australia*. Queensland Museum Booklet No.12. Queensland Museum, Brisbane.

Jolly, S. 1995. Common Sheathtail Bat, *Taphozous georgianus* Pp. 472- 474 *in* R. Strahan (ed.) *The Mammals of Australia*. Reed Books, Chatswood.

Koopman, K.F. 1984. Taxonomic and distributional notes on tropical Australian bats. *American Museum Novitates* No. 2778.

McKean, J.L and Price, W.J. 1967. Notes on some Chiroptera from Queensland, Australia. *Mammalia* 31, 101-119.

Pavey, C.R. 1995. *The foraging ecology of a guild of insectivorous bats (Rhinolophoidea) in eastern Australia: a test of resource partitioning theory*. PhD Thesis. University of Queensland, Brisbane (unpublished).

Pavey, C.R. 1998. Colony sizes, roost use and foraging ecology of *Hipposideros diadema reginae*, a rare bat from tropical Australia. *Pacific Conservation Biology* 4, 232-239**.**

Pavey, C.R. 1999. Foraging ecology of the two taxa of large-eared horseshoe bat, *Rhinolophus philippinensis*, on Cape York Peninsula. *Australian Mammalogy* 21, 135-138.

Pavey, C.R. and Burwell, C.J. 2000. Foraging ecology of three species of hipposiderid bats in tropical rainforest in north-east Australia. *Wildlife Research* 27, 283-287.

Richter, A.R., Humphrey, S.R., Cope, J.B. and Black, V. Jr. 1993. Modified cave entrances: thermal effect on body mass and resulting decline of endangered Indiana bats (*Myotis sodalis*). *Conservation Biology* 7, 407-415.

Schulz, M. and de Oliveira, M.C. 1995. Microchiropteran fauna of Kroombit Tops, central Queensland, including a discussion on survey techniques. *Australian Zoologist* 30, 71-77.

Schulz, M. and Menkhorst, K. 1984. Notes on the Lesser Warty-nosed Horseshoe Bat (*Hipposideros stenotis*). *Australian Bat Research News* 20, 14-16.

Tate, G.H.H. 1952. Results of the Archbold Expeditions No 66. Mammals of Cape York Peninsula, with notes on the occurrence of rainforest in Queensland. *Bulletin of the American Museum of Natural History* 98, 563-616.

Tidemann, C.R., Priddel, D.M., Nelson, J.E. and Pettigrew, J.D. 1985. Foraging behaviour of the Australian ghost bat, *Macroderma gigas* (Microchiroptera : Megadermatidae). *Australian Journal of Zoology* 33, 705-713.

Thomson, B.G. 1989. *A Field Guide to the Bats of the Northern Territory*. Conservation Commission of the Northern Territory, Darwin.