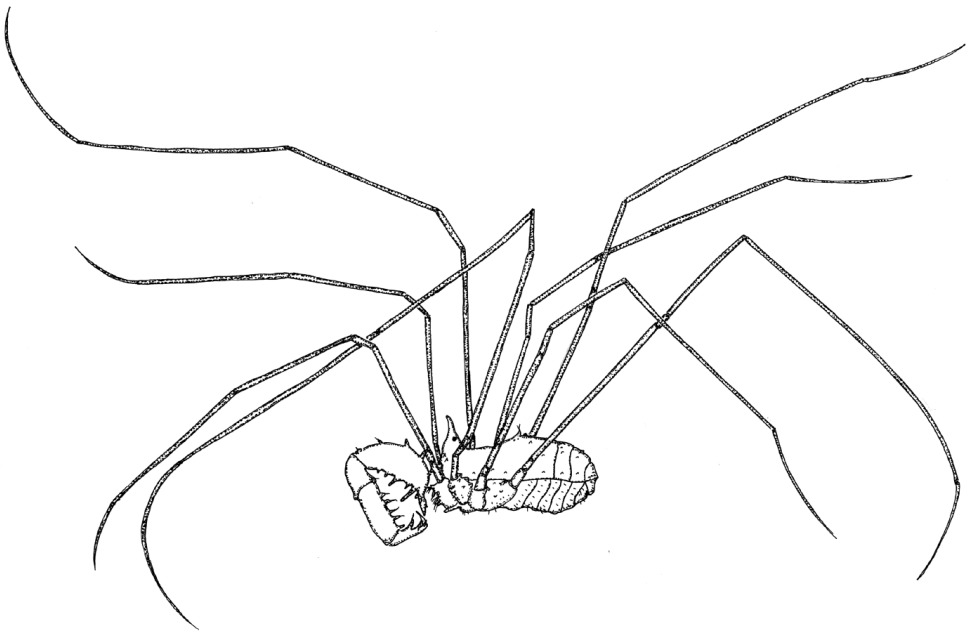
Reconnaissance Survey of

Cave Fauna Management Issues in the

Mole Creek Karst National Park, Tasmania

Stefan Eberhard



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Reconnaissance Survey of Cave Fauna Management Issues in the Mole Creek Karst National Park, Tasmania.

Stefan Eberhard

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PART 1 INTRODUCTION

1.1 Aims

1. To undertake cave fauna surveys in the Mole Creek karst area to identify locations of rare and sensitive habitats and species.

2. To provide recommendations on the conservation status of cave fauna species in the Mole Creek karst area.

3. To develop management options for the protection of cave fauna in the Mole Creek karst area.

4. To assist the Karst Officer (WHA) in developing an integrated management plan for the Mole Creek karst area by providing advice on cave fauna management.

1.2 Scope

The short time period (12 weeks) available to undertake the work, limited the scope of the project to caves located within the Mole Creek Karst National Park (MCKNP), and some caves located immediately adjacent to the MCKNP. This constraint made it more difficult to assess the biological values of the caves within the broader regional context of the Mole Creek karst area. The assessment was additionally restricted by the small size and fragmented structure of the cave reserves, with major parts of the catchments and fauna distributions often located outside the reserves, on private farmland or State Forest.

In the absence of a comprehensive, regional baseline survey, and quantification of impacts, an initial attempt is made to appraise the conservation status of species and threats to habitats. For each cave surveyed, biological and non-biological management issues were identified, discussed and management recommendations given. These discussions and recommendations will be relevant to the preparation of the overall management plan for the MCKNP and Mole Creek karst generally. General management options developed for cave fauna at Ida Bay (Eberhard 1999) will be applicable to Mole Creek.

The species listed for each cave are not comprehensive since they were compiled from single visits during this survey. Relevant records from the literature, such as type locality records, and some kindly provided by Arthur Clarke are also included. Additional records for the caves surveyed during this project, and other caves in the Mole Creek karst, may be found elsewhere in Eberhard *et al.* (1991) and Clarke (1997). Comprehensive assessments of cave biodiversity require numerous visits to the same site over a period of time to detect the rare species. However, the species records collected during this survey have permitted a useful appraisal of rare and threatened species distribution ranges to be made, and the lists represent an initial baseline for future reference.

1.3 Methods

Twenty six caves were visited during February and March 1999. These sites represent the majority of known caves located within the MCKNP. A number of caves located just outside the boundaries of the MCKNP were also visited, especially those hydrologically connected to caves in the MCKNP, or otherwise relevant to the study for biological or visitor and catchment management reasons. Not all sites of potential interest or management relevance could be visited owing to the limited time available for this work. However, priority was given to the sites considered to be most at risk, or of management interest.

Between three and five hours were spent searching for fauna in each cave, and most caves were visited only once. Easily identifiable species such as the Tasmanian Cave Spider (*Hickmania troglodytes*) and cave crickets (*Micropathus cavernicola*) were recorded but not collected. Voucher specimens of undescribed and unidentified material were collected and preserved in 70% ethanol. All collected material is lodged at the Queen Victoria Museum in Launceston, except for some specimens of crangonyctoid amphipods given to Dr John Bradbury (University of Adelaide).

In addition to recording the species present in each cave, observations were made of sensitive and vulnerable habitats and other non-biological values. Consideration was given to identifying immediate and future management issues, both biological and non-biological, and providing recommendations.

The caves surveyed during this study are listed in Table 1.

Table 1. Caves Surveyed During Study. The caves are grouped within their respective catchments following the scheme of Kiernan (1984). Abbreviations: NP = National Park; P = private (+ block no.); WHA = World Heritage Area; SF = State Forest; MVC = Mersey Valley Council. ? indicates uncertainty about land tenure

Cave Number	Cave Name	Catchment	Tenure of Entrance	Location
MC203	Wet Cave	Mole-Lobster	NP,P (0975)	146°24'E, 41°36'S
MC201	Georgies Hall	Mole-Lobster	P	146°24'E, 41°36'S
MC64	Westmorland Cave	Mole-Lobster	MVC (0993)	146°24'E, 41°38'S
MC84	Honeycomb 1 Cave	Mole-Lobster	NP	146°24'E, 41°36'S
MC107	Honeycomb 2 Cave	Mole-Lobster	P (1005)	146°24'E, 41°36'S
MC120	Marakoopa 1 Cave	Mayberry	NP/WHA	146°17'E, 41°35'S
MC132	Anastomosis	Mayberry	NP/WHA	146°17'E, 41°35'S
MC127	Devils Drainpipe	Mayberry	NP/WHA	146°17'E, 41°35'S
MC208	Snailspace Cave	Mayberry	SF	146°17'E, 41°35'S
MC221	Sprite Cave	Mayberry	P (1205)	146°19'E, 41°34'S
MC119	King Solomons Cave	Loatta	NP	146°15'E, 41°33'S
MC12	Queen of Sheba	Loatta	NP	146°15'E, 41°33'S
MC18	Soda Creek Cave	Loatta	NP/P?	146°14'E, 41°33'S
MC6	Diamond Cave	Loatta	NP/P (2192)?	146°15'E, 41°33'S
MC28	Howes Cave	Loatta	P (2201)	146°17'E, 41°33'S
MC38	Genghis Khan	Loatta	NP	146°17'E, 41°33'S
MC1	Kubla Khan	Loatta-Mayberry	NP, P (1217)	146°17'E, 41°33'S
MC96	Sassafras Cave	Sassafras	NP	146°21'E, 41°34'S
MC102	Sassafras Inflow	Sassafras	P (1167)	146°21'E, 41°34'S
MC?	Wombat Cave	Sassafras	P (1166)	146°21'E, 41°34'S
MC32	Baldocks Cave	Sassafras	NP	146°20'E, 41°35'S
MC17	Cyclops Cave	Sassafras	NP	146°21'E, 41°35'S
MC16	Glowworm Cave	Sassafras	NP	146°21'E, 41°35'S
MC13	Croesus Cave	Mill	NP	146°13'E, 41°35'S
MC14	Lynds Cave	Mill	NP	146°13'E, 41°34'S
MC64	Tailender Cave	Mill	NP	146°13'E, 41°35'S

PART 2 SPECIES CONSERVATION STATUS

All wildlife found in caves within State Reserves (i.e. MCKNP) may not be taken without a permit from the Minister for National Parks and Wildlife. In addition, a number of cave dwelling species are protected under the *National Parks & Wildlife Act 1970* (see Schedules 1 and 2 of the *Wildlife Regulations 1999*) whether they occur in reserves or not. This legislation is especially relevant at Mole Creek where there are significant populations of protected species occurring in caves outside reserves, where they may be subject to threatening processes. Protected cave species known to occur in the Mole Creek area are: glowworms, *Arachnocampa tasmaniensis;* crickets, *Micropathus cavernicola* and *Parvotettix goede;* beetles, *Tasmanotrechus cockerilli* harvestman, *Hickmanoxyomma gibbergunyar* and pseudoscorpions, *Pseudotyrannochthonius typhlus*.

Three of these species (*T. cockerilli, H. gibbergunyar* and *P. typhlus*) are confined to caves and are endemic to the Mole Creek karst. The other three species are not confined to caves and are more widely distributed. *A. tasmaniensis* occurs in caves and moist forest habitats throughout Tasmania. *M. cavernicola* is recorded from Mole Creek, Loongana and other karst areas in the west of Tasmania (Richards 1971). Although it also occurs in forest habitats, the cave populations reach higher densities. *P. goedei* is widely distributed in Tasmania (Mesa 1970) and is not considered to be threatened.

Three of the Mole Creek cave species mentioned above are also listed on the Tasmanian *Threatened Species Protection Act 1995*. The species are: *Tasmanotrechus cockerilli* (vulnerable), *Hickmanoxyomma gibbergunyar* (rare) and *Pseudotyrannochthonius typhlus* (rare)

None of the rare, threatened or protected species occurring in MCKNP caves were imminently threatened, either by internal threatening processes (e.g. human visitors) or external threatening processes (e.g. catchment disturbance). Note that this statement only refers to the status of the six listed species known from caves in the MCKNP. Whilst the survival of these species (in the biological sense) appears to be secure, this does not imply that some populations of these species may not in fact be under threat in areas outside the MCKNP, or even become threatened in the future within the MCKNP. No definite conclusions are made with respect to the conservation status of the large number of presently unidentified or undescribed taxa which also inhabit the Mole Creek caves - this is especially relevant in the case of aquatic fauna which will be more sensitive to catchment disturbances through the hydrologic system.

This survey has provided useful new distribution records for these species which enables a re-appraisal of their conservation status to be made (see detailed appraisal later below).

2.1 *Tasmanotrechus cockerilli*

Tasmanotrechus cockerilli is a rare and highly cave modified (eyes vestigial) beetle belonging to the Tribe Trechinae (Family Carabidae). Originally described from Georgies Hall by Moore (1972), it was also collected from Herberts Pot, within the same cave drainage subsystem, and Scotts Cave, within the same karst catchment (Mole Creek-Lobster Rivulet). A specimen collected from Kellys Pot, part of the Georgies Hall-Herberts Pot system, was initially considered to be a separate species (B. Moore pers. comm. *in* Eberhard *et al.* 1991), but then subsequently assigned to *T. cockerilli* by Moore (1995).

Tasmanotrechus cockerilli was listed as vulnerable in view of the potential catchment disturbance occurring within its known limited range (Invertebrate Advisory Committee 1994). During this survey, *Tasmanotrechus* was collected from several new cave localities and its known distribution has been extended to include the Loatta catchment. Comparison of specimens from these new localities with Moore's original drawings and specimens collected from the Georgies Hall-Wet Cave system, suggest that they are the same species. Independent and expert verification of this determination may be wanting, but in my opinion all the collected material belongs to *T. cockerilli.* Unfortunately some earlier collected material from Little Trimmer Cave, Genghis Khan and Kubla Khan Caves could not be examined because the material is currently in the possession of a beetle specialist overseas (Dr L.C. Genest, France).

The discovery of *T. cockerilli* within the Marakoopa Creek karst subsystem is important for the conservation status of this species, as this subsystem is the only part of its known distribution where the entire catchment area is protected within a State Reserve (MCKNP).

Tasmanotrechus cockerilli appears to be reasonably widely distributed and generally fairly rare in any given cave, but occasionally locally abundant. It is not as rare as *Goedetrechus mendumae* at Ida Bay (Eberhard 1999). Further survey work is likely to reveal numerous new cave site records. *Tasmanotrechus* has not been recorded from caves in the Mill Creek, Dogs Head, or the Mersey Hill catchment. Future surveys should search for the taxon in these catchments.

Whilst individual cave populations of *T. cockerilli* may become threatened, the species as determined by this survey may be considered secure. Thus, it may be justifiable to downlist the species from vulnerable to rare status.

Tasmanotrechus cockerilli is recorded from the catchments and caves listed below:

Mole-Lobster catchment:	Georgies Hall (Moore 1972)
	Herberts Pot (Moore 1972)
	Kellys Pot (Moore 1995)
	Wet Cave (present study)
Mole Creek catchment:	Scotts Cave (Moore 1972)
Sassafras catchment:	Cyclops Cave (present study)
	Baldocks Cave (present study)
	Wombat Cave (present study)
Mayberry catchment:	Marakoopa 1 (Goede 1973)
	Snailspace Cave (present study)
	Devils Drainpipe (Woolhouse, unpublished report 1982)
	Anastomosis (present study)
Mayberry-Loatta catchment:	Kubla Khan Cave* (refer Kubla Khan Management Plan)
	Genghis Khan Cave* (refer Kubla Khan Management Plan)
Loatta:	Diamond Cave (present study)
	Little Trimmer Cave* (Eberhard *et al.* 1991)
Mill catchment:	Not recorded
Mersey Hill catchment:	Not recorded
Dogs Head catchment:	Not recorded

* A distinctly different species of troglobitic carabid beetle was collected during the Kubla Khan management plan survey - this material still remains to be identified by Dr Genest in France. In addition, Dr Barry Moore (pers. comm.) refers to an unconfirmed and possibly spurious, but nonetheless intriguing, record of the genus *Idacarabus* from Mole Creek. The possibility should not be dismissed that there may be other new species of cave beetle awaiting discovery at Mole Creek.

Recommendations:

- Change the conservation status of *Tasmanotrechus cockerilli* from vulnerable to rare under the *Threatened Species Protection Act 1995*.
- Search for *Tasmanotrechus* sp. in the Mill Creek, Dogs Head and Mersey Hill catchments.
- Confirm by expert identification and/or genetic studies, the discreteness or otherwise, of different cave populations of *Tasmanotrechus cockerilli* .
- Secure return of all the Tasmanian cave beetle material loaned in 1991 to Dr L.C. Genest (France). The material includes unique specimens from Mole Creek and other remote areas (WHA) which will be extremely difficult to replace.

2.2 *Pseudotyrannochthonius typhlus*

The Mole Creek cave pseudoscorpion *Pseudotyrannochthonius typhlus* was described by Dartnall (1970) from material collected in Georgies Hall (type locality) and Baldocks Cave (paratype locality). Additional unidentified material belonging to this genus was later collected from Kellys Pot, Kubla Khan, Genghis Khan and Little Trimmer (Eberhard *et al.* 1991). Specimens assigned to *P. typhlus* have also been collected from Scotts Cave and Shiskebab (A. Clarke RFA database). During this survey specimens were collected from Wombat Cave and Marakoopa Creek karst system (Devils Drainpipe). The material was sent for identification to Dr Mark Harvey (Western Australian Museum), who compared all the collected material (except Little Trimmer Cave, Scotts Cave and Shiskebab) with the original type specimens.

Mark Harvey's comments were: "I can find no consistent differences between specimens from the various catchments, and conclude that they all represent the same species, *P. typhlus.* The holotype was considered by Dartnall to be a male - it is in fact a female! The material I have examined is listed:

1f (holotype), 1 deutononymph (paratype) Sennacheribs Passage, Georgies Hall
1 tritononymph (paratype) Baldocks Cave
1m Wombat Cave
2f Devils Drainpipe
2m Kubla Khan
1 tritononymph [+2 chelae of adult m] Genghis Khan
1 protonymph/deutonoymph Kellys Pot".

There is a need for *Pseudotyrannochthonius typhlus* to be redescribed in view of Dartnall's wrong sexing and the poor condition of the type material (M. Harvey pers. comm.). The discovery of *P. typhlus* within the Marakoopa Creek karst subsystem is important for the conservation status of this species, as this subsystem is the only part of its known distribution where the entire catchment area is protected within a State reserve (MCKNP). *P. typhlus* is recorded from the catchments and caves listed below:

Mole-Lobster catchment:	Georgies Hall (Dartnall 1970)
	Kellys Pot (Eberhard *et al.* 1991)
	Shiskebab (Collection record 1985, Queen Victoria Museum)
	Scotts Cave (Collection record 1968; SA Museum)
Sassafras catchment:	Baldocks Cave (Dartnall 1970)
	Wombat Cave (present study)
Mayberry catchment:	Devils Drainpipe (present study)
Mayberry-Loatta catchment:	Kubla Khan Cave (refer Kubla Khan Management Plan)
	Genghis Khan Cave (refer Kubla Khan Management Plan)
Loatta catchment:	Little Trimmer Cave, probably *P. typhlus* (Eberhard *et al.* 1991)
Mill catchment:	Not recorded
Mersey Hill catchment:	Not recorded
Dogs Head catchment:	Not recorded

P. typhlus is an extremely rare animal. The species is known from about a dozen specimens. To give an example, only three individuals were sighted in two of the 26 caves surveyed during this project. Collection of further specimens from existing known cave localities is not considered necessary.

Recommendations:

- Maintain listing of *Pseudotyrannochthonius typhlus* as rare on the *Threatened Species Protection Act 1995.*
- Search for *Pseudotyrannochthonius typhlus* in the Mill Creek, Dogs Head, and Mersey Hill catchments.
- Support taxonomic redescription of the species.

2.3 *Hickmanoxyomma gibbergunyar*

The Mole Creek cave harvestman *Hickmanoxyomma gibbergunyar*, described by Hunt (1990), is a troglobite that is endemic to the Mole Creek karst. Baldocks Cave is the holotype locality, with a number of additional paratype localities within the Mole Creek karst drainage subsystem (Honeycomb Cave, Wet Cave, Herberts Pot, Westmorland Cave, Cow Cave-Pyramid link), plus one unspecified cave at Mole Creek (Hunt 1990). During this survey, the recorded distribution range for this species was extended to include a number of caves in the Marakoopa karst drainage subsystem within the MCKNP. This discovery is an important improvement for the conservation status of this species.

H. gibbergunyar appears to be reasonably widely distributed, generally fairly rare in any given cave, but occasionally locally abundant. Further survey work is likely to reveal numerous new cave site records. There are other species of harvestmen recorded from caves at Mole Creek (Eberhard *et al.* 1991). *H. gibbergunyar* is recorded from the catchments and caves listed below:

Mole-Lobster catchment:	Georgies Hall (Hunt 1990)
	Herberts Pot (Hunt 1990)
	Honeycomb Cave (Hunt 1990)
	Wet Cave (Hunt 1990)
	Westmorland Cave (Hunt 1990)
	Cow Cave-Pyramid Cave link (Hunt 1990)
Sassafras catchment:	Cyclops Cave (present study)
	Baldocks Cave (Hunt 1990)
	Wombat Cave (present study)
Mayberry catchment:	Anastomosis (present study)
Mayberry-Loatta catchment:	Kubla Khan Cave (refer Kubla Khan Management Plan)
Loatta catchment:	Not definitely recorded
Mill catchment:	Not recorded
Mersey Hill catchment:	Not recorded
Dogs Head catchment:	Not recorded

The conservation status of this species appears to be secure, although individual cave populations may become threatened as a result of internal or external threatening processes. It is of interest to note that the species was seen

abundantly on riparian sediment banks in Sassafras Cave. The catchment of this cave has been extensively cleared, resulting in a changed flow regime that has probably involved a greater influx of sediment and nutrients in the form of wood.

Recommendations:

- Maintain listing of *Hickmanoxyomma gibbergunyar* as rare on the *Threatened Species Protection Act 1995.*
- Search for *Hickmanoxyomma gibbergunyar* in the Loatta, Mill Creek, Dogs Head, and Mersey Hill catchments.

2.4 Other Localised Species

There are a number of undescribed taxa that are considered likely to qualify for listing when they become fully described. This statement is made in view of the apparent troglobitic status of many of these taxa, and, their likely restricted distributional range (i.e. Mole Creek karst). The taxa include:

Eucrenonaspides sp. (Syncarida: Psammaspididae)
Antipodeus spp. (Amphipoda: Paramelitidae)
Heterias sp. (Isopoda: Janiridae)
Styloniscus spp. (Isopoda: Styloniscidae)
'*Lakeamphisopus trogloendemicus*' (Isopoda: Phreatoicidea)
Icona sp. (Araneae: Theridiidae)
Amaurobiidae Gen. et sp. nov. (Araneae)
Opiliones spp. (Arachnida)
Carabidae sp. (Coleoptera)
Enicocephalidae sp. (Hemiptera)
Adelphoderia sp. (Collembola)
?*Campodea* sp. (Diplura)

It is very likely this list will be extended when further collections and determinations come to hand.

A subterranean phreatoicid species was described as '*Lakeamphisopus trogloendemicus*' by Knott (1975). The description remains unpublished and therefore not recognised. The material was collected from Mersey Hill Cave and Marakoopa 2 Cave. Additional stygobitic phreatoicid material has been collected from water-filled caves in the Den Plain (Eberhard *et al.* 1991). Phreatoicids are sensitive to water quality changes (G. Wilson pers. comm.), so it would be prudent to get the Mole Creek material described as it may prove to be a useful bio-indicator.

Other prominent aquatic groups in Mole Creek caves include Hydrobiidae, Amphipoda, and Syncarida (*Anaspides* and *Eucrenonaspides*). These groups may also be sensitive to water quality changes, so taxonomic description of these groups should also be encouraged.

An unidentified species of dipluran (?*Campodea* sp.) is recorded from Croesus Cave (Eberhard *et al.* 1991). This is the only record from Tasmania of an apparently troglomorphic member of this group, and therefore of some interest and significance.

An unidentified species of enicocephalid hemipteran is recorded from Kellys Pot (Eberhard *et al.* 1991). This is one of only two records from Tasmania of an apparently troglomorphic member of this group, and therefore of some interest and significance.

Recommendations:

- Support taxonomic description of subterranean Amphipoda from Mole Creek (and elsewhere in Tasmania). Contact Dr John Bradbury (University of Adelaide).
- Support taxonomic description of subterranean Phreatoicidea from Mole Creek (and elsewhere in Tasmania). Contact Dr George Wilson (Australian Museum).
- Support taxonomic description of subterranean Hydrobiidae from Mole Creek (and elsewhere in Tasmania). Contact Dr Winston Ponder (Australian Museum).
- Support taxonomic description of subterranean Pseudoscorpionida from Mole Creek (and elsewhere in Tasmania). Contact Dr Mark Harvey (Western Australian Museum).
- Support taxonomic description of subterranean Araneae from Mole Creek (and elsewhere in Tasmania). Contact Dr Mike Gray (Australian Museum) and others.
- Support taxonomic description of subterranean Collembola from Mole Creek (and elsewhere in Tasmania). Contact Dr Penny Greenslade (CSIRO Division of Entomology).
- Support taxonomic description of other subterranean groups from Mole Creek (and elsewhere in Tasmania), including: Syncarida (*Anaspides* and *Eucrenonaspides*), Diplura, Enicocephalidae and Opiliones.

PART 3 THE CAVES

This section deals with the biology and management issues for each individual cave surveyed. The caves are grouped into their respective catchments following the scheme of Kiernan (1984). For each cave, several key points are listed and discussed, where necessary, under separate sub-headings. Recommendations and a fauna list are given at the end of each sub-section. The key points considered for each cave are listed below in order of appearance:

Land tenure (of entrance)
Catchment status
Biological values
Cave contains protected species (if not in reserve)
Cave contains rare or threatened species
Cave may contain other protected or threatened species: (based on known distribution and habitat characteristics of the species)
Non-biological values
Internal threats
External threats
Management issues
Recommendations
Fauna list: (where a '?' is placed next to a species name, this indicates that the species identity has not been confirmed by an appropriate taxonomic authority)

3.1 Mole-Lobster Catchment

3.1.1 Westmorland Cave MCx64

Land tenure: Mersey Valley Council (block no. 0993).

Catchment status: Part of catchment is in MCKNP (Westmorland Falls Reserve), and Crown Land.

Biological values: The cave is highly significant for biology. It contains a spectacular glowworm display.

Cave contains protected species: *Arachnocampa tasmaniensis, Tasmanotrechus cockerilli and Micropathus cavernicola.*

Cave contains rare or threatened species: *Tasmanotrechus cockerilli.*

Cave may contain other protected or threatened species: *Hickmanoxyomma gibbergunyar, Pseudotyrannochthonius typhlus.*

Non-biological values: The cave is significant for hydrology because it is one of the major inflow caves to the Mole Creek - Lobster karst system. It is also significant for geomorphology and recreation.

Internal threats: Cave is predominantly a high-energy streamway that is resilient to visitor impacts. However, the cave contains fauna sensitive to trampling (e.g. cave beetles) or disturbance by people moving through low passages (e.g. glowworms on low roofs), but no serious threat is envisaged providing that MIC rules are adopted by visitors.

External threats: Diversion of inflow stream for water supply. Potential land disturbance within surface catchment area.

Management issues: The principal management issue concerns the diversion of the inflow stream for water supply. Under drought flow conditions, the entire stream flow is artificially captured and diverted away from the cave entrance. The water is used for agricultural purposes downstream. Under high flow conditions the stream overflows the diversion conduit and enters the cave.

The ecology of Westmorland Cave is dependent upon the inflow stream supplying water and nutrients. The hydrobiology of the Mole Creek - Lobster karst system (which includes Wet Cave and Honeycomb Cave amongst others) is at least partly dependent upon the Westmorland inflow. One of the other major inflow caves is Kellys Pot where there is no diversion of inflow or other catchment disturbance. There are other inflow points to the Mole Creek system located on cleared land, or land subject to various disturbance.

Maintenance of the natural, constant base-flow conditions is important to the ecology of Westmorland Cave. Glowworms are abundant in the cave despite the partial diversion of base-flow over many years. The glowworm population is dependent upon the stream to carry in a food supply of aquatic insects. Evidently there is sufficient overflow entering the cave to maintain this population. Whether or not the population has suffered a decline as a result of the diversion is not known in the absence of earlier baseline data. The diversion has been in place for many decades. The persistence of the glowworm colony in Westmorland Cave indicates that the ecological consequences of the diversion are relatively minor for this component of the fauna at least. Glowworm colonies are known to be sensitive to changes in stream flow regime, including increased flooding and sedimentation (Pugsley 1984, Williams 1975). The glowworm colony in Flowery Gully Cave, Tasmania, has all but disappeared, probably as a consequence of catchment clearance affecting the cave stream (Kiernan 1977).

Maintaining the base-flow into the entrance of Westmorland Cave would be of no consequence to the glowworms if, for example, this relatively small flow was completely absorbed into the deep clastic floor sediments before it reached the glowworm chamber - this possibility needs to be considered. The effect of the diversion on other cave fauna, especially aquatic fauna, is likely to be very localised and essentially confined to a maximum few hundred metres length of stream passage between the entrance and the sump at the bottom of the known cave. This is unlikely to interfere with the normal distribution of species or populations given the high frequency of overflow events when 'invertebrate drift' and mixing of populations can occur.

Irrespective of this speculation, not far into the cave there is a side stream entering which contains amphipods, whilst the sump pool contains *Anaspides tasmaniae* - both these species suggest a relatively normal, healthy aquatic ecosystem. In addition, Westmorland Cave also contains a typical cave stream riparian fauna, which includes terrestrial troglobites such as the cave beetle *Tasmanotrechus cockerilli.*

I found no evidence of deleterious effects to the ecology of Westmorland Cave that may be directly attributed to the partial diversion of base-flow from the entrance. In the absence of necessarily prolonged and detailed studies to determine otherwise, I can see no compelling argument for restoring base-flow on existing ecological evidence. There may be an argument for restoring base-flow on general ecological principles, but this must be weighed against other considerations which include the users of the water supply, the potential benefits and disadvantages, and costs of the undertaking. There may be far more crucial management issues at Mole Creek where resources can be more usefully spent.

If it is decided however, that the present water supply system will be altered to return more of the base-flow into Westmorland Cave, then the ecological effects should be investigated by, for example, monitoring the glowworm population. However, this would need to be undertaken as a properly designed prospective study involving a preliminary period of monitoring (12 months minimum and sensibly much longer than this, to account for variation between years) before any changes are made.

Recommendations:

- If the water supply system at Westmorland Cave is altered then empirical evidence of the resultant ecological changes, if any, should be obtained. This needs to be undertaken as a properly designed BACI (Before-After-Control-Impact) study.
- No restrictions on access are considered necessary to protect biological values, but the fauna may benefit if visitors are aware of MIC techniques.

Fauna List	**Recorded by**
Hickmania troglodytes	SE observed 1999
Amaurobiidae sp.	SE collected 1999
Triaenonychidae sp.	SE collected 1999
Amphipoda sp.	SE collected 1999
Arachnocampa tasmaniensis	SE observed 1999
Ephemeroptera sp.	SE observed 1999
Hickmanoxyomma gibbergunyar	Hunt 1990
Tasmanotrechus cockerilli	Moore 1995

3.1.2 Wet Cave (MC203) – Georgies Hall (MC201)

Land tenure: Outflow entrance (MC203) is National Park. Most of cave including Georgies Hall entrance lies within private land.

Catchment status: Multiple land tenure including private, State Forest, Crown Land and National Park.

Biological values: Wet Cave and especially Georgies Hall are biologically important because they are the type locality for three troglobitic species - all of which are listed as rare or threatened. Georgies Hall is the holotype locality for *Tasmanotrechus cockerilli* Moore and *Pseudotyrannochthonius typhlus* Dartnall. *P. typhlus* was collected on moist sand and vegetable debris in stream passages (Sennacheribs Passage). Wet Cave is one of several paratype localities of *Hickmanoxyomma gibbergunyar* Hunt. Georgies Hall is also important because it contains an outstanding example of tree roots and tree root habitat (Root Hall).

Cave contains protected species: *Arachnocampa tasmaniensis, Tasmanotrechus cockerilli, Micropathus cavernicola and Hickmanoxyomma gibbergunyar* (paratype locality).

Cave contains rare or threatened species: *Tasmanotrechus cockerilli* (holotype locality), *Pseudotyrannochthonius typhlus* (holotype locality)

Non-biological values: Georgies Hall contains spectacular speleothem deposits that have been extensively trampled and muddied.

Internal threats: Trampling and muddying of speleothems in Georgies Hall. Wet Cave is a medium/high-energy stream environment, which is biologically resilient to visitor impacts.

External threats: Catchment disturbance.

Management issues: Biological management issues revolve around protecting Root Hall and recognising the importance of Georgies Hall as a type locality. The roots and rare cave species are not considered to be overtly threatened by cave visitors, so long as MIC techniques are adopted.

There is a definite need for improved route marking across speleothem surfaces in Georgies Hall. Some reflective markers were placed many years ago by the Southern Caving Society but these need to be improved. Unfortunately extensive tracking of mud has already occurred. Much of the muddied areas would be difficult to rehabilitate. Improved route marking to protect speleothems may indirectly benefit the roots and fauna.

Another management issue concerns access because the entrance of Georgies Hall and the side entrance of Wet Cave are located on private land. At present, Georgies Hall experiences low visitation because the entrance is located on private land and the route through from Wet Cave involves route finding through a rockfall. The route is well worn but not obvious to visitors in Wet Cave unless they are experienced cavers and/or determined to find the way through.

No access restrictions are considered necessary for Georgies Hall at present, but its location should not be promoted.

Recommendations:

- Undertake route marking in Georgies Hall.
- Do not facilitate general public access to Georgies Hall.
- The fauna may benefit if visitors are aware of MIC techniques.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Metidae sp.	SE coll. 1999
?Baalzebub sp.	SE obs. 1999
?*Hickmanoxyomma gibbergunyar*	SE obs. 1999
Anaspides tasmaniae	SE coll. 1999
Tasmanotrechus cockerilli	SE coll. 1999
Parvotettix goedei	SE obs. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Symphyla sp.	SE coll. 1999

Pseudotyrannochthonius typhlus	Dartnall 1970
Tasmanotrechus cockerilli	Moore 1972

3.1.3 Honeycomb 1 Cave (MC84)

Land tenure: MCKNP

Catchment status: Multiple land tenure including private, State Forest, Crown Land and National Park.

Biological values: With its multiple entrances and shallow maze-like structure, the environment of Honeycomb 1 is poorly buffered from environmental changes on the surface. Many of the passages in the cave are subject to strong (sometimes desiccating) air currents, with large and frequent changes in temperature and humidity. Much of the cave essentially consists of an extended transition zone environment, with conditions that do not suit troglobitic species, nor other invertebrates which are anemophobic or prone to desiccation (refer Eberhard 1999). The lower levels are subject to fairly intense back-flooding. It is likely however, that troglobitic species may be found in blind side passages that are suitably moist and environmentally buffered.

With its numerous entrances, Honeycomb 1 contains a good representation of twilight and transition zone habitats. Whilst the fauna may not be particularly prominent, the twilight zone flora is well developed and there are good examples of the gradation in species composition along the declining light gradient. Blackberries are also prominent.

Cave may contain protected or threatened species:
Arachnocampa tasmaniensis
Tasmanotrechus cockerilli
Micropathus cavernicola
Hickmanoxyomma gibbergunyar
Pseudotyrannochthonius typhlus

Non-biological values: Honeycomb 1 has been a popular and important recreational site for many years. It is probably the most frequently visited undeveloped cave in northern Tasmania.

Internal threats: High visitation rates by casual visitors with little or no knowledge of sensitive fauna and habitats. *Hickmania troglodytes* may be affected in some places where people break webs to access passages, or where some passages are used so frequently that the spiders are precluded from occupying these sites.

Erosion and trampling of twilight zone flora and sediments; trampling and muddying of speleothems, especially tracking of mud onto calcite floors.

External threats: Catchment disturbance.

Management issues: No serious fauna management issues were identified, however species such as *Hickmania troglodytes* in particular, may benefit from MIC practices. Trampling of twilight zone flora may need to be managed in some locations by defining appropriate routes.

An important management issue in Honeycomb 1 concerns the tracking of mud onto calcite surfaces, and the general progressive degradation resulting from high visitation levels. Near some entrances there is conspicuous loss of vegetation cover and development of soil erosion problems. The effects of the high visitation are acutely evident in the sections used by group that abseil into the vertical entrance and then walk out the lower entrances. The main passage connecting the base of the shaft to the lower level entrance has been seriously degraded and muddied. The degradation that is permitted to happen in this passage, though localised, does have wider implications to cave conservation generally.

There is the possibility that some of the groups using this section of cave for an adventure caving experience, may not be receiving the best education message in relation to sensitive cave environments and MIC. By allowing groups to trample mud without a second thought, across what was once a clean calcite floor, does not promote cave conservation or MIC. The risk is that such a 'casual' attitude will tend to prevail with the visitors to this site and they may carry this attitude with them when they visit other sites, especially if they are beginners or otherwise untrained in caving. However, if an effort is clearly being made to minimise degradation to, or even rehabilitate, this section then future visitors will be exposed to cave conservation ethics in practice, whilst still able to enjoy their caving experience. Limiting numbers of visitors, or closing-off this section of cave, will not solve the bigger problem in the long term.

Initiating pro-active cave conservation and education actions in Honeycomb 1 is arguably one of the best ways for Parks & Wildlife Service to:

1. promote cave conservation more effectively and more widely, and;

2. interact with the cave user groups, especially those groups which are more difficult to contact because they may not be affiliated with the caving clubs, or other easily identifiable group, and;

3. interact with, and promote cave awareness in the local community, by for example, school field excursions and/or cave cleaning exercises.

Honeycomb 1 is an ideal location to develop a self-guided karst and cave public interpretation walk.

Recommendations:
- Initiate conservation and public outreach actions in Honeycomb 1, especially in relation to use of the vertical entrance and associated passages.
- I support the development of a self-guided karst and cave public interpretation walk.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Anaspides tasmaniae	A. Clarke 1997
Copepoda sp.	T. Illife 1987
Styloniscus cf. *nichollsi*	A. Clarke 1997

3.1.4 Honeycomb 2 Cave (MC107)

Land tenure: Private

Catchment status: Multiple land tenure including private, State Forest, Crown Land and National Park.

Biological values: Cave is a roost site for bats and Boobook owl.

The upper levels in Honeycomb 2, like Honeycomb 1, are poorly buffered from environmental changes on the surface. Many of the passages in the cave are subject to strong (sometimes desiccating) air currents, with large and frequent changes in temperature and humidity. Much of the cave essentially consists of an extended transition zone environment, with conditions that do not suit troglobitic species, nor other invertebrates which are anemophobic or prone to desiccation (refer Eberhard 1999). The lower levels provide a more suitable environment however, and it is likely that troglobitic species may be found here, or in blind upper level passages. The lower levels are subject to severe backflooding.

Honeycomb 2 also contains a good representation of twilight and transition zone habitats. Whilst the fauna may not be particularly prominent, the twilight zone flora is well developed and there are good examples of the gradation in species composition along the declining light gradient. Blackberries are also prominent.

Cave contains protected species: *Arachnocampa tasmaniensis, Parvotettix goedei.*

Cave may contain protected or threatened species: *Tasmanotrechus cockerilli, Micropathus cavernicola, Hickmanoxyomma gibbergunyar and Pseudotyrannochthonius typhlus.*

Non-biological values: Honeycomb 2 contains calcite floors vulnerable to mud tracking and soft sediments with breakable calcite crusts.

Internal threats: Most of the cave is relatively robust, except for some localised areas of soft sediment with breakable crust, and calcite floors potentially subject to muddying.

External threats: Catchment disturbance.

Management issues: No serious fauna management issues were identified. The downstream entrance contains an example of twilight zone flora that is vulnerable to trampling. However, Honeycomb 2 has survived in much better condition than Honeycomb 1 because the entrance is not obvious and located further from the Wet Caves Reserve

carpark. The entrance may be situated just outside the reserve boundary on private land. If more casual visitors frequented the cave, such as in Honeycomb 1, then the degradation rate would be accelerated. However, the potential for mud tracking is not so acute as in Honeycomb 1, so long as visitors take care.

Recommendations:

- Maintain low visitation rates by not advertising the cave location or facilitating access (e.g. side effect from development of karst interpretation walk). Periodically monitor (e.g. photo-monitoring) trampling impacts.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Metidae sp.	SE coll. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Parvotettix goedei	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. small-fast type	SE coll. 1999
Hemiptera sp. (Spittle bug)	SE coll. 1999
Gastropoda sp.	SE obs. 1999

3.2 Sassafras Catchment

3.2.1 Baldocks Cave (MC32)

Land tenure: MCKNP

Catchment status: State Forest

Biological values: Baldocks Cave has great biological conservation significance.

It is the type locality for a number of species including the holotype locality for the Mole Creek cave harvestman *Hickmanoxyomma gibbergunyar* Hunt 1990 and the paratype locality for the Mole Creek cave pseudoscorpion *Pseudotyrannochthonius typhlus* Dartnall 1970. It is probably the holotype locality for the Tasmanian Cave Spider which was the first cave dwelling species to be described in Australia in 1883 (Higgins & Petterd 1883) (Clarke 1999a).

Cave contains old wood that is colonised by troglobitic species.

Cave contains rare or threatened species: *Tasmanotrechus cockerilli, Hickmanoxyomma gibbergunyar and Pseudotyrannochthonius typhlus.*

Non-biological values: The cave is an old tourist cave containing artifacts with historical significance. It is popular with visitors, including members of caving groups and an adventure tour operator.

Internal threats: Disturbance of and interference with webs of *Hickmania troglodytes*, including females with egg sacs. Removal of old wood which is important habitat, and which is colonised by a significant numbers of rare troglobitic species.

External threats: Catchment disturbance, e.g. forestry operations.

Management issues: Management of Baldocks Cave requires recognition of its considerable importance for:
(i) biological conservation (type locality of rare and significant species); (ii) historical values (old tourist cave); and (iii) recreational and educational activities.

Cave spiders may be disturbed, albeit unintentionally, when people use the side entrance MC33, or enter the short side passage on the right not far inside the main entrance MC32. These are the main sites occupied by *H. troglodytes* in Baldocks Cave, and the only sites observed to have females with egg sacs. The spiders require particular environmental conditions for their egg sacs (Doran 1992; Doran *et al.* 1997; Doran *et al.* in prep.). Protection of these maternity sites is clearly important for the local cave population. The fact that females with egg sacs were observed at both sites indicates that they can tolerate at least some level of human disturbance. However, keeping the level of disturbance to a minimum is considered desirable, especially in view of the importance of this site as the probable type

locality for the species, and the opportunity for visitors to easily view and appreciate this large and spectacular creature.

The side passage near the main entrance has been designated a fauna sanctuary in the manner described in Eberhard (1999). A string with explanatory sign has been installed partway along the passage, at a point just before where spider webs are encountered. The location of the barrier prevents people from inadvertently walking into the spider webs that are strung across the passage beyond this point, but still allows visitors to fully view and appreciate the animals. The passage extends only a short distance further and there is no need for people to enter any further. It would be prudent to periodically monitor the population of spiders within the sanctuary. This could be undertaken by Parks & Wildlife personnel or any interested speleologists who regularly visit the cave. When the sanctuary was installed on 31 March 1999, the sanctuary contained one female with two egg sacs, one subadult, and 26 cave crickets - these numbers were obtained by thoroughly searching the entire sanctuary area, however for future counts it is important to remain beyond the barrier.

Currently, this is the only fauna sanctuary installed in a Mole Creek cave. As well as helping to protect the spiders in Baldocks Cave, the existence of this sanctuary will hopefully help to raise the level of awareness amongst visitors, of cave faunal values generally and more widely elsewhere.

Protection of the spiders dwelling in the side entrance MC32 is more problematical given there is no way of installing a sanctuary without closing off access to the entrance gate. This is not such a great problem for visitors since the main entrance is only a short distance away. If a sanctuary were to be installed here, a stringline barrier could be placed across the passage just a few metres before the gate - this would still enable visitors to fully view and appreciate the fauna and the side entrance opening. It would be an interesting experiment to trial a sanctuary in this location and monitor it to see if the spider population increases.

In Baldocks Cave there are considerable quantities of old timber, a legacy from its former use as a tourist cave early this century. The timber is colonised by troglobitic species, including the harvestman and pseudoscorpion, which are found more abundantly on the old timber than any other substrate in the cave. Although other wood occurs naturally in the cave (e.g. tree roots of large diameter, wood fragments brought in by the stream), it is the old hardwood timber that is the preferred habitat for these species.

Wooden materials are a potential food source and habitat for cave fauna. Although this wood may not have arrived underground by natural processes, it should not necessarily be regarded as an undesirable pollutant unless it comprised timber treated with biocides. Wood is transported into certain parts of caves by natural processes of gravity and water flow, as well as through the growth of tree roots. Humanly transported wood can increases fauna numbers and diversity by providing a food source in the often food-poor cave environment. The timber in Baldocks Cave has been colonised only by species normally found in cave environments and no native cave species appear have been displaced. This timber has also increased the habitat of rare and protected troglobitic species.

As a potential pollutant, wood is relatively benign and, as a potential energy source, is relatively low in nutrients. Its effects upon the cave ecology are minimal compared with other nutrient-rich pollutants such as sewage and fertilisers for example. Wood left in caves will eventually decompose although this process may take many years. Most cave organisms are generalists so they are able to exploit a range of food sources, and for many species the microflora associated with wood decomposition represents one of their natural food items.

The impact of wood upon cave ecology is not necessarily adverse, depending upon its location in the cave. Wood might be considered an undesirable pollutant when it occurs in large quantities, or where it occurs in places where it is unlikely to have arrived there by natural means, such as low energy upper level passages. Most of the wood in Baldocks is located in reasonable proximity to the streamway or the entrance. This must be balanced against impacts on geomorphological values, such as cave sediments and speleothems which are being invaded by fungal growths and hyphae, and by locally increased acidity of waters in the vicinity of wood deposits. This is a particular concern where the wood has been left near speleothems.

Whether or not to remove old wood from caves is difficult to assess. To do so abruptly might cause some upset to the cave ecology by removing the food source for populations that have come to depend on it over time. Clean-up operations which involve the removal of old wood amongst other rubbish, sometimes appear to be motivated primarily by a desire to re-instate conditions which existed prior to human involvement, rather than by any real threat to the underground ecology. Indeed, it could be argued that abruptly removing the wood, especially if it has been *in situ* for a long period, will be more disruptive to the ecology than leaving it alone. The process of collecting and removing the wood can cause the death of quite a number of cave animals as occurred during the clean-up operations in Newdegate Cave at Hastings.

Before old wood is removed from caves, the potential impact on the cave ecology should be considered. An alternative approach might be to remove the wood gradually, or to remove only a portion of the wood and leave some lying *in situ* for the fauna. When removing wood, care must be taken not to kill or remove fauna as well. This can be achieved by searching the wood for animals and releasing them, or knocking the wood on the ground to dislodge them. The fauna remaining behind may not survive if all the wood is removed, and if alternative food sources are not available. However, small fragments of wood will often be left *in situ* (assuming vacuum cleaners are not used) which will sustain the fauna for some time, thus lessening the acute impact whilst the ecosystem settles into a new equilibrium.

The old timber in Baldocks Cave is clearly of biological and historical significance. It is not having a detrimental impact upon the underground ecology. Quite the reverse is true in fact, as the wood is supporting populations of listed rare and protected species. Removal of the wood will not threaten the survival of the listed species, but it will likely have an impact on their local abundance in this cave. The wood has both historical and ecological interpretation value, enabling visitors to easily view animals that would otherwise not be seen. However, it is affecting the geomorphological values of underground sediment and speleothem deposits. A balance must be reached in which the essentially irreplaceable geomorphological values of the cave are preserved, whilst maintaining the distribution and abundance of faunal communities in an optimum state, and protecting the caves historical value.

Recommendations:

- Maintain and monitor the fauna sanctuary near the main entrance MC32.
- Consider installing a fauna sanctuary at the side entrance MC33, and monitor the recovery or otherwise of fauna.
- In terms of fauna, there is no need to remove the old timber. However, this must be balanced with assessment of the timber's impact on abiotic values .

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Icona sp. (Tb)	SE obs. 1999
?Baalzebub sp.	SE obs. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
?Anapidae sp.	SE coll. 1999
Hickmanoxyomma gibbergunyar	Hunt 1990
Opiliones sp. indet. (Tp)	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Antipodeus sp. (Tb)	A. Clarke coll. 97-98
Micropathus cavernicola	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. small-fast type	SE coll. 1999
Diptera sp. indet.	SE coll. 1999
Tasmanotrechus cockerilli	Moore 1972
Diplopoda sp. (Tp)	SE coll. 1999
Hydrobiidae sp.	A. Clarke coll. 97-98
Oligochaeta sp.	SE coll. 1999

3.2.2 Sassafras Cave (MC96) and Sassafras Inflow (MC102)

Land tenure: partly MCKNP, and Private

Catchment status: cleared Private land, State Forest

Biological values: Glowworm display, troglobitic species and a rich twilight and transition zone fauna, including numerous spiders and crickets. In the upper level passage there are extremely localised and patchily distributed communities of invertebrates associated with tree roots and/or decomposing wombat droppings. A wombat, Tasmanian devil, and Boobook owl use cave.

Cave contains protected species: *Arachnocampa tasmaniensis, Micropathus cavernicola, Hickmanoxyomma* ?*gibbergunyar.*

Cave contains rare or threatened species: *Hickmanoxyomma* ?*gibbergunyar,*

Cave may contain other protected or threatened species: *Tasmanotrechus cockerilli, Parvotettix goedei and Pseudotyrannochthonius typhlus.*

Non-biological values: Cave is important for recreation. Cave contains speleothems, including vulnerable floor features. Cave is important for hydrological relationships.

Internal threats: No serious threats identified, but MIC practices will help minimise disturbance of glowworm threads, and trampling of sensitive habitats and fauna. The upper level passage contains some very localised communities of invertebrates associated with tree roots and/or decomposing wombat droppings - these are not obvious and may be vulnerable to trampling.

Although located in a reserve, the cave at present does not appear to be widely known or visited by people outside the speleological fraternity. Most of the damage to speleothems that is evident, probably occurred many years ago. Access to the cave is currently limited by the lack of obvious public thoroughfares leading to the site, although this situation may change in the future and needs to be addressed in future management planning.

External threats: Catchment disturbance, especially run-off from cleared farmland that drains into Sassafras Inflow MC102 and thence directly into Sassafras Cave.

Management issues: The area of the Sassafras Cave reserve essentially covers the stream outflow entrance (MC96), but not the inflow entrance (MC102) or any of the stream catchment.

The major management issue for Sassafras Cave concerns the pre-existing catchment disturbance where land clearance immediately upstream of the inflow point (MC102) has altered the flow regime. The land clearance has likely resulted in more rapid, more sporadic run-off, with higher and flashier peak flows. Large quantities of timber and sediment have been mobilised and now completely plug the entrance of the inflow cave MC102. This is not a typical condition for cave entrances in undisturbed catchments.

The ecology of the stream is also likely to have been affected by a reduction in shading effect and nutrient inputs resulting from loss of riparian vegetation, and, increased scouring effects on the stream bed and organisms. The flow regime is likely to have been modified to become more intermittent, thus potentially affecting the life cycles of aquatic organisms. For a more detailed discussion of the hydrological and ecological effects of land clearance, refer to Eberhard and Hamilton-Smith (1996) or Eberhard (1999).

There is likely to be nutrient enrichment of the stream derived from run-off from cattle pasture, with potential for other pollutants or toxins originating from agricultural activities immediately upstream. Stock has direct access to the inflow stream that is located on private land.

Despite the evident catchment disturbance, there still remains a healthy glowworm population in Sassafras Cave, which indicates that at least the food supply for the glowworms which consists of aquatic insects, has not been entirely depleted. However, the size of the glowworm colony prior to land clearance is not known. In addition to the persistence of glowworms, the terrestrial troglobite *Hickmanoxyomma* ? *gibbergunyar* is reasonably abundant on riparian sediment banks.

Future management strategies for Sassafras Cave might aim to restore the catchment conditions so far as practicable, by minimising nutrient enrichment and ameliorating the present flashy flow regime. This could involve excluding stock from having direct access to the creek, and revegetating the stream banks to provide a buffer zone. Because the inflow stream traverses private land, it might be feasible to enter into some sort of conservation and/or rehabilitation agreement with the landholder.

Access to the cave is currently limited by the lack of obvious public thoroughfares leading to the site, although this situation may change in the future and needs to be addressed in future management planning. If catchment restoration is undertaken then the efficacy of this needs to be assessed by monitoring the hydrological and ecological effects.

Recommendations:

- Investigate means of restoring stream catchment conditions upstream of the Sassafras Cave inflow (MC102).

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
?*Baalzebub* sp.	SE coll. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999

Stiphidiidae sp.	SE coll. 1999
Metidae sp.	SE coll. 1999
?Anapidae sp.	SE coll. 1999
?Mimetidae sp.	SE coll. 1999
Araneae spp. indet.	SE coll. 1999
?*Hickmanoxyomma gibbergunyar*	SE coll. 1999
Acarina sp.	SE coll. 1999
Styloniscidae sp. (Tp)	SE coll. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Micropathus cavernicola	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. small-fast type	SE coll. 1999
Fulgoroidea sp. nymph	SE coll. 1999
Collembola sp.	SE coll. 1999
Coleoptera sp. (Ac)	SE coll. 1999
Trechine larva (?Tb)	SE obs. 1999
Neuroptera sp.	SE coll. 1999
Ephemeroptera sp.	SE obs. 1999
Diplopoda sp. (Tp)	SE coll. 1999
Gastropoda sp.	SE coll. 1999
Oligochaeta sp.	SE coll. 1999
Paludicola sp.	SE obs. 1999

3.2.3 Cyclops Cave (MC17)

Land tenure: MCKNP

Catchment status: State Forest

Biological values: Cave contains troglobitic species, stream and riparian habitats, tree roots.

Cave contains rare or threatened species:
Tasmanotrechus cockerilli

Cave may contain other rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar*.

Non-biological values: Cave is important for speleologists and adventure tour operations. Cave contains speleothems. Cave is important for hydrological relationships.

Internal threats: No serious threats to fauna identified.

External threats: Low potential for catchment disturbance (e.g. forestry), affected through hydrological connection with My Cave.

Management issues: No serious fauna management issues were identified, but the fauna may benefit from MIC practices. Most of the cave is a reasonably robust medium energy stream environment. Beyond a deep pool near the end is a small chamber containing moist sediments which is good habitat for troglobites. The deep pool helps to limit visitor numbers to this section of cave.

Recommendations: No specific fauna management recommendations presently identified.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
?Metidae sp.	SE coll. 1999
Araneae spp. indet. x 3	SE coll. 1999

Hickmanoxyomma gibbergunyar	SE coll. 1999
Styloniscidae sp. (Tp)	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Aphididae sp.	SE coll. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. small-fast type	SE coll. 1999
Diptera sp. medium-fast type	SE coll. 1999
Diplopoda sp. (Tp)	SE coll. 1999
Gastropoda sp.	SE coll. 1999
Hydrobiidae sp.	SE obs. 1999

3.2.4 Wombat Cave

Land tenure: Private

Catchment status: Private, State Forest

Biological values: Cave contains troglobitic species. Cave contains evidence of usage by wombats and devils.

Cave contains protected species: *Micropathus cavernicola, Parvotettix goedei, Hickmanoxyomma gibbergunyar, Pseudotyrannochthonius typhlus and Tasmanotrechus cockerilli.*

Cave contains rare or threatened species: *Tasmanotrechus cockerilli, Hickmanoxyomma gibbergunyar* and *Pseudotyrannochthonius typhlus*

Non-biological values: Cave contains speleothems covered in sediments possibly of recent origin. Important for speleological investigations.

Internal threats: No serious threats to fauna identified, but MIC practices will help minimise disturbance.

External threats: Potential for flooding effects through catchment activities.

Management issues: No serious fauna management issues were identified, but the fauna may benefit from MIC practices.

Recommendations: No specific fauna management recommendations identified.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
?Baalzebub sp.	SE coll. 1999
?Anapidae sp.	SE coll. 1999
Hickm*anoxyomma gibbergunyar*	SE coll. 1999
Pseudotyrannochthonius ?*typhlus*	SE coll. 1999
Microtrombidium sp.	SE coll. 1999
Styloniscidae sp. (Tp)	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Tasmanotrechus cockerilli	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Parvotettix goedei	SE coll. 1999
Tipulidae sp.	SE coll. 1999
Diptera sp.	SE coll. 1999
Diplopoda spp. x 2	SE coll. 1999
Oligochaeta sp.	SE obs. 1999

3.2.5 Glowworm Cave (MC16)

Land tenure: MCKNP

Catchment status: Private, State Forest

Biological values: Cave contains glowworms.

Cave contains protected species: *Arachnocampa tasmaniensis, Micropathus cavernicola.*

Cave may contain other protected, rare or threatened species: *Parvotettix goedei, Hickmanoxyomma gibbergunyar, Pseudotyrannochthonius typhlus and Tasmanotrechus cockerilli.*

Non-biological values: Important for hydrology, geomorphology.

Internal threats: No serious internal threats to fauna identified. Cave is small and rarely visited for recreation.

External threats: Catchment disturbance.

Management issues: No serious fauna management issues were identified. Cave is small and rarely visited for recreation.

Recommendations: No specific fauna management recommendations identified.

Fauna list:	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Micropathus cavernicola	SE obs. 1999

3.3 Mayberry Catchment

Several caves located within the Marakoopa Creek drainage system were not surveyed, most notably Devils Pot, Devils Earhole, Marakoopa 2, and some recent minor discoveries such as Scrawny Cave and Demdem Cave. The fauna of these caves is likely to be the same or similar to the other caves which were sampled within the Marakoopa Creek drainage system. No major threats are likely to affect Devils Pot, Devils Earhole, and Marakoopa 2, given their location, visitation levels, and occurrence within the WHA. However, the possibility that they may contain significant fauna and sensitive habitats needs to be investigated.

3.3.1 Marakoopa 1 Cave (MC120)

Land tenure: MCKNP (WHA)

Catchment status: MCKNP (WHA)

Biological values: Marakoopa 1 Cave contains a spectacular glowworm display that is a major attraction on the guided cave tours. It is the best example of such an attraction in any Australian tourist cave. Marakoopa Cave contains other species such as *Anaspides tasmaniae*, *Hickmania troglodytes* and *Micropathus cavernicola*, which can be seen on the cave tours and included in the guide's interpretation.

Marakoopa Cave is significant for biological conservation value because it is an integral part of the Marakoopa Creek karst drainage subsystem. This is the only karst drainage subsystem within the Mole Creek karst where the entire catchment remains essentially undisturbed (by land clearance, farming and forestry activities), and, where the entire catchment is completely protected within the WHA. It represents a potentially useful reference site.

The cave is the type locality of a protected species, *Micropathus cavernicola* Richards 1964.

Cave contains rare or threatened species: *Tasmanotrechus cockerilli.*

Cave may contain other rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar*.

Non-biological values: Cave is a guided tourist cave. Cave is important for hydrology, geomorphology, sedimentology, speleology and recreation.

Internal threats: No serious internal threats to survival of cave fauna were identified, but some remarks are made below.

Cave entrance gate and excavations may have modified previous cave climate/air flow patterns and affected cave cricket migrations - but there are still small openings present which are used by cave crickets. The entrance modifications are not considered a serious management issue in terms of fauna conservation, but noted for reference.

Tourists may occasionally trample underfoot cave dwelling species, including rare troglobitic species such as *Tasmanotrechus cockerilli.* This is not considered a serious management issue, but noted for reference.

Lampenflora - not observed to be a significant problem due to cleaning.

External threats: None identified.

Management issues: For the operation of the tourist cave and interpretation value, it is important to ensure the continued viability of the glowworm population in particular, and the other large and prominent species such as *Anaspides tasmaniae* and *Hickmania troglodytes.* For the glowworms and *Anaspides tasmaniae* this is primarily a matter of maintaining the natural hydrological and stream food supply conditions, and cave climate. The protected surface catchment area should ensure this occurs without the need for major management intervention.

Considering the importance of the glowworm display on the cave tour, it may be prudent to monitor the health of the colony on a regular basis, especially in view of the considerable variations in abundance observed at different times of the year (C. Shaw pers. comm.). These variations may be in response to seasonal changes in food supply and/or cave climate, but this remains to be verified. A monitoring program would aim to determine this, as well as providing useful information for public interpretation and future management planning. Another advantage of such long term monitoring is to provide a baseline reference upon which to investigate any future possible declines in abundance.

It has been suggested that the Cave Spider *Hickmania troglodytes* is less abundant in tourist caves compared with non-tourist caves (N. Doran pers. comm.). This speculation remains to be scientifically verified, although obviously spiders will be less abundant where tourist pathways directly impinge upon their potential web sites. However, whether the lights and noise, etc significantly compromises the spiders over wider areas has not been precisely measured. I have observed spiders in webs right beside pathways, and one important question is how long they remain there? The spiders, especially juveniles and subadults may be quite mobile, shifting their web locations in search of food supplies, egg sac sites, or mates. In order to answer this question most adequately it would be necessary undertake a Before-After-Control-Impact (BACI) designed experiment, to compare the frequency of spider movements in a site before disturbance (viz. tourists absent) and after disturbance (tourists present).

Baseline monitoring of glowworms and spiders can be relatively simply accomplished with little expenditure of time and money. The task is greatly facilitated in a tourist cave by the ease of access and regular (up to daily) visitation by personnel who are in a position to easily note subtle changes which would not otherwise be detected with less frequent visitation. Cave guides by virtue of their daily visits to the same sites, are in a unique position to make regular observations and note unusual behaviours which would not otherwise be possible for other researchers who visit sites much less frequently (e.g. monthly at Ida Bay). Valuable observations can be made by cave guides fairly quickly and simply with little extra time involved. The monitoring needs to be undertaken as a properly designed prospective study however, to ensure consistency of methods and validity of results.

Recommendations:

- Consider monitoring of glowworms and cave spiders in Marakoopa Cave.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp.	SE obs. 1999
Anaspides tasmaniae	SE obs. 1999
Styloniscus sp. nov. B	Eberhard et al. 1991

Tasmanotrechus cockerilli	SE coll. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Micropathus cavernicola (type locality)	Richards 1964
Hydrobiidae sp.	A. Clarke pers. comm.

3.3.2 Anastomosis (MC132)

Land tenure: MCKNP (WHA)

Catchment status: MCKNP (WHA)

Biological values: Cave is an integral part of the Marakoopa Creek karst drainage subsystem. This is the only karst drainage subsystem within the Mole Creek karst where the entire catchment remains essentially undisturbed (by land clearance, farming and forestry activities), and, where the entire catchment is completely protected within the WHA. Connected with Devils Pot and Marakoopa Cave system.

Cave contains rare or threatened species: *Tasmanotrechus cockerilli, Hickmanoxyomma* ?*gibbergunyar.*

Cave may contain other protected or threatened species: *Pseudotyrannochthonius typhlus.*

Non-biological values: Cave contains speleothems and sediments that are vulnerable to trampling and damage. Cave is important for recreational caving as it is connected underground with Devils Pot.

Internal threats: No serious internal threats to survival of cave fauna were identified. Considerable trampling and damage of fragile speleothem coated sediments has occurred. Cavers may occasionally trample underfoot rare troglobitic species such as *Tasmanotrechus cockerilli.*

External threats: None identified.

Management issues: The principal management issue in this cave concerns the irreversible degradation of fragile speleothems and sediments. The degradation is exacerbated by the use of this cave as a popular 'sporting' through trip to Devils Pot. Some route marking is definitely required to protect fragile floor formations, whilst clearly defining the route to Devils Pot may reduce unnecessary visitation and impacts to other fragile sections of the cave.

Biological values are not overtly threatened, but the fauna may benefit from MIC practices.

Recommendations:

- Undertake route marking to protect fragile floor formations, and clearly define the route through to Devils Pot.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
?Anapidae sp.	SE coll. 1999
Hickmanoxyomma ?*gibbergunyar*	SE coll. 1999
Opiliones sp. (Tp)	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Tasmanotrechus cockerilli	SE coll. 1999

3.3.3 Devils Drainpipe (MC127)

Land tenure: MCKNP (WHA)

Catchment status: MCKNP (WHA)

Biological values: This cave was identified as a site of biological importance by speleologists (refer Mathews 1985 *Australian Karst Index*) and was confirmed during the current survey. The cave contains a very large cricket colony that is part of a community of diverse and abundant cave dwelling species.

The cave is also important because it is an integral part of the Marakoopa Creek karst drainage subsystem. This is the only karst drainage subsystem within the Mole Creek karst where the entire catchment remains essentially undisturbed (by land clearance, farming and forestry activities), and, where the entire catchment is completely protected within the WHA.

The cave floods intermittently depositing sediment and particulate organic matter that probably forms the basis of the food chain in the deep zone.

The cave may be an important future biological reference or study site.

Cave contains rare or threatened species: *Tasmanotrechus cockerilli*, *Hickmanoxyomma* ?*gibbergunyar*, *Pseudotyrannochthonius typhlus.*

Non-biological values: The cave contains laminated sediment banks with organic material that are sensitive to trampling impacts. The cave contains areas of calcite floor that are subject to mud tracking. The cave is an important site for speleological investigations, particularly its relationship to the Marakoopa Cave hydrological system.

Internal threats: Because of the abundance of fauna and confined nature of the cave passages, the fauna is significantly vulnerable to human disturbance and trampling impacts.

External threats: None identified.

Management issues: This cave should be managed primarily for its faunal values, which may be impacted by human visitation. The severity of impacts to the fauna will be related to the frequency of visitation and degree of MIC practiced. Route marking will not substantially benefit the fauna because of the narrow passages.

The very large population of crickets in this cave occurs on a low roof which visitors must crawl under. Unless particular care is taken not to disturb the colony whilst crawling underneath, the crickets tend to panic and jump off the roof where they are easily trampled. As soon as one cricket panics it tends to initiate a wave of panic through the rest of the colony. The best thing to do if this happens is to sit still for a while to give the crickets time to get out of the way and settle down again.

On the moist mudbanks in the lowest levels especially there are abundant populations of troglobitic species, the most notable of which are the cave beetles but also amaurobiid spiders, symphylans, and the extremely rare pseudoscorpions. Numerous beetles were reported in the lower levels by Bob Woolhouse in 1982, whilst in the same year Albert Goede reported millipedes (A. Clarke RFA database).

The small size of the passage and abundance of fauna makes it vulnerable to trampling. Unless special care is taken some individuals are likely to be trampled underfoot. Occasional visitation by experienced cavers being extremely mindful of the fauna is not considered a major threat to the populations in this cave. However, if visitation became reasonably frequent, especially by persons not taking extreme care to avoid the fauna, then the populations might begin to suffer.

It is possible that visitation levels to this cave may increase in the future as speleological investigations attempt to find a connection with the rest of the Marakoopa Cave system. Illegal digging operations at the bottom level (which is where the troglobitic fauna is concentrated) may be disruptive to the fauna, depending on the amount of material moved and any resultant alterations to air flow patterns.

Recommendations:

- Manage Devils Drainpipe as a site of biological conservation significance.
- No access restrictions are considered necessary at this stage, but the frequency of speleological activities in this cave need to be monitored, especially any potential digging activities.
- General 'sport' caving trips to this cave should be discouraged. All visitors should be experienced in MIC techniques for fauna.
- Notify the caving clubs and any other potential cave visitors of the biological sensitivity of this site (cite the issues above), and the preferred management option of minimal visitation combined with high MIC requirements.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
Araneae sp. indet.	SE coll. 1999

Pseudotyrannochthonius ?*typhlus*	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Diptera sp. small-fast type	SE coll. 1999
Collembola sp.	SE coll. 1999
Tasmanotrechus cockerilli	SE coll. 1999
Diplopoda spp. x 2 (Tp)	SE coll. 1999
Symphyla sp.	SE coll. 1999
Gastropoda sp.	SE coll. 1999
Terricola sp.	SE coll. 1999

3.3.4 Snailspace (MC208)

Land tenure: State Forest

Catchment status: MCKNP (WHA)

Biological values: Cave contains troglobites and tree roots. The cave is important because it is apparently part of the Marakoopa Creek karst drainage subsystem. This is the only karst drainage subsystem within the Mole Creek karst where the entire catchment remains essentially undisturbed (by land clearance, farming and forestry activities), and, where virtually the entire catchment is completely protected within the WHA.

Cave contains protected species: *Tasmanotrechus cockerilli, Micropathus cavernicola.*

Cave contains rare or threatened species: *Tasmanotrechus cockerilli.*

Cave may contain other protected or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar*.

Non-biological values: Cave contains fragile speleothems and floor crusts that are sensitive to trampling impacts and mud tracking.

Internal threats: No significant internal threats to fauna identified, although floor dwelling fauna in the low level crawlways is vulnerable to being trampled. MIC techniques are needed in the upper level passages containing fragile tree roots and floor formations.

External threats: Proximity of entrances to the picnic area may result in inexperienced persons visiting the cave.

Management issues: No serious fauna management issues identified, but there is a definite need for route marking in the upper levels. Despite the relatively recent discovery of this cave by experienced speleologists (Kiernan 1984), a significant amount of irreversible degradation has been allowed to occur. The problem is the tracking of mud onto speleothems, and especially, the unnecessary disturbance and breakage of fragile floor formations. Much of this could have been avoided if the first explorers had placed route markers at the time of their exploration - this is considered normal practice by many speleologists, especially interstate where the cave resources are much more limited. The conservation ethics and exploration practices of Tasmanian speleologists and cave visitors generally needs to be brought in line with modern standards, particularly because most cave degradation tends to occur on the first few trips into a cave. A sense of stewardship and duty of care towards fragile cave environments, as opposed to the 'underground gymnasium for fun and sport' type of attitude, needs to be promoted. In addition, a sense of responsibility to actively participate in rectifying inadequate route marking, or rehabilitating existing degraded areas, needs to be encouraged amongst the speleological fraternity.

Considering the proximity of Snailspace Cave to the picnic area, there is a risk that inexperienced persons may enter the cave and do damage to themselves or the cave. The upper level of the cave is fragile whilst the lower level crawlways are robust and relatively safe for casual visitors to explore on their own, although some care is required with route finding deeper inside. It would be prudent to monitor the visitation and impacts to this cave.

Recommendations:

- Undertake route marking in the upper levels.

- No access restrictions are considered necessary at this stage, but the frequency of visitation and degradation rates should be monitored (e.g. periodic photo-monitoring of upper level floor areas). Gating may need to be considered at some stage in the future.
- Promote route marking practices, rehabilitation, and the Minimum Impact Caving Code of the Australian Speleological Federation to caving groups.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp. (Tb)	SE obs. 1999
Icona sp. (Tb)	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Tasmanotrechus cockerilli	SE coll. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. small-fast type	SE coll. 1999
Diptera sp. medium-fast type	SE coll. 1999

3.4 Loatta Catchment

3.4.1 King Solomons Cave

Land tenure: MCKNP

Catchment status: Private

Biological values: The fauna, although sparsely represented, is of considerable value for interpretation by guides running the cave tours. The occurrence of old spider webs covered in lint suggests that *Hickmania troglodytes* may once have been more abundant in this cave. The abundance of cave spiders and cave crickets may have been reduced by the solid entrance door and sealing of one other old entrance.

The occurrence of troglobitic species (Amaurobiidae and Isopoda) in close proximity to the paths within this heavily visited tourist cave is of some interest. The occurrence of troglobitic fauna on old wood placed in the cave, and in the vicinity of the proposed tunnel excavation into Queen of Sheba, is also relevant.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus*, *Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli.*

Non-biological values: The cave is a popular tourist cave. It contains speleothems, sediments and bone deposits, and has a geohydrological relationship with Soda Creek drainage subsystem.

Internal threats: Proposed excavation of new entrance through Queen of Sheba Cave. Possibly reduced abundance of cave crickets and cave spiders caused by solid entrance door and sealing of one other entrance. Trampling of cave fauna by tourists.

External threats: Catchment disturbance affecting presumed stream passage that underlies the upper level passages. Includes potential for sewage derived from the King Solomons Cave area toilets and residence, to enter the karst and Soda Creek drainage system.

Management issues: No serious biological management issues were identified with the cave in its present condition. However, if the proposed tunnel is excavated into Queen of Sheba then some of the cave fauna and other values may be affected (see further discussion below).

The occurrence of troglobitic isopods on old wood placed in the cave (including near the old acetylene generator, but especially the old ladder beyond the tourist section) needs to be considered as discussed for Baldocks Cave (refer Section 3.2.1).

The abundance of cave crickets and cave spiders may be limited by the solid entrance door and sealing of one other old entrance. For their interpretative values, it may be possible to increase the populations of these species in the cave by enhancing access to the surface (e.g. small holes in the entrance door area that allow movement of invertebrates). The effect of this on cave climate and speleothem growth would need to be considered.

The principal management issue confronting King Solomons Cave concerns the congestion of visitors in this small cave with narrow pathways. With large groups of people the quality of the tour experience for visitors is compromised. To ease congestion there have been proposals to create a through trip by excavating a tunnel and exit through Queen of Sheba Cave. This proposal is fraught with a number of difficulties including:

- protection of speleothems during excavation and removal of material;
- maintenance of cave microclimate conditions which may affect speleothem growth and fauna;
- cost of excavation;
- cost of Before-After Control-Impact (BACI) monitoring.

The connection between the two caves is solidly plugged with rocks, sediment and calcite. The occurrence of troglobitic spiders (*Icona* sp.), which are susceptible to air currents and desiccation, at this point in the cave suggests that air flow through here is absent or very limited. If the connection was not sealed then noticeable air flow between the two entrances would be expected to occur. The air flow that is detectable at the end of the tourist section may be emanating from the downward shaft containing the old wooden ladder. If a connecting tunnel is excavated then the cave microclimate will be changed and this may affect moisture levels and speleothem growth. Whilst this could be controlled by installing an air-lock door, at least 12 months Before-Impact monitoring would need to be undertaken to characterise the present conditions.

There exists however, a more pragmatic alternative to the potentially high fiscal and environmental costs associated with the tunnel excavation. The alternative involves developing the original tourist entrance above the acetylene generator. This development would involve much less alteration to the cave structure and environmental conditions, less risk to cave values, and would probably be a lot cheaper in the long run. The development of the old tourist entrance would facilitate visitor traffic management, especially during peak periods when tour size numbers could be reduced but the frequency of tours could be increased. This would enhance the quality of the tour. The old tourist entrance is located nearly three quarters of the way along the approximately 185 metres of tourist pathway into the cave. Developing this entrance as an optional exit point would significantly ease the congestion problem. The entrance is conveniently located above Solomons Chamber that is sufficiently spacious to facilitate management of visitor traffic. The only back-tracking required would be the final short section of passage at the end. The development of the old tourist entrance might involve some minor excavation, and would require installation of a steep stairway which might be a problem for some people (e.g. elderly), but there still remains the option of returning through the other entrance in these circumstances.

Another important management issue concerns the potential for pollutants to enter the karst and Soda Creek drainage system. Potential pollutants include sewage derived from the King Solomons Cave area toilets and residence, and, petroleum hydrocarbons derived from the road and carpark. Grey water from the residence is discharged directly into the karst. The toilets drain into septic tanks. All of these potential pollutant sources are situated very close to King Solomons Cave, and virtually overlying the Soda Creek karst drainage system. The potential for pollution from these sources to affect the Soda Creek Cave spring is considered quite high. Kiernan (1984) recorded high levels of coliform bacteria in the spring, although the source could also have been from pasture lands located further upstream in the catchment. Nonetheless, management strategies must be developed, and actions undertaken, to minimise the risk of pollutants entering the karst system from the identified sources within the MCKNP, and more widely elsewhere in the catchment.

Recommendations:

- To better manage visitor traffic and improve the quality of cave tours, consider development of the old tourist entrance in King Solomons Cave in preference to excavating a tunnel through Queen of Sheba Cave.
- To improve opportunities for fauna interpretation, consider enhancing entrance access for crickets and spiders.
- Consider the habitat value of old wood for resident cave fauna.
- Develop and implement strategies to minimise risk of pollutants entering the Soda Creek karst drainage system from the identified sources within the MCKNP, and more widely elsewhere in the catchment.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
Icona sp. (Tb)	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Talitridae sp.	SE coll. 1999
Parvotettix goedei	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Diptera sp. type 1	SE coll. 1999

3.4.2 Queen of Sheba Cave (MC12)

Land tenure: MCKNP

Catchment status: MCKNP, Private

Biological values: Contains troglobitic species (Amaurobiidae) and tree roots.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli*

Non-biological values: Important for speleothems and genetic relationship to King Solomons Cave.

Internal threats: Proposed excavation of tunnel into King Solomons Cave causing disruption to microclimate conditions and fauna.

External threats: As for King Solomons Cave - catchment disturbance affecting presumed stream passage which underlies the upper level passages, and, potential for pollutants (e.g. sewage, petroleum hydrocarbons) derived from the King Solomons Cave area to enter the karst and Soda Creek drainage system (refer Section 3.4.1).

Management issues: No serious biological management issues were identified with the cave in its present condition. However, if the proposed tunnel is excavated into King Solomons Cave then some of the cave fauna and other values may be affected - refer to discussion for King Solomons Cave above. The tunnel excavation would result in major modifications to the internal structure and environment of Queen of Sheba Cave. The present condition of Queen of Sheba Cave could be maintained however, by developing the old tourist entrance in King Solomons Cave instead.

The potential for pollutants to enter the Soda Creek karst drainage system, of which Queen of Sheba forms a part, is discussed under King Solomons Cave above (refer Section 3.4.1).

Recommendations:

- Consider development of the old tourist entrance in King Solomons Cave in preference to excavating a tunnel through Queen of Sheba Cave.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp.	SE obs. 1999
?Baalzebub sp.	SE coll. 1999
Parvotettix goedei	SE coll. 1999
Diptera sp. type 1	*SE coll. 1999*

3.4.3 Diamond Cave (MC6)

Land tenure: NP/Private?

Catchment status: Private

Biological values: The cave contains troglobitic species. The cave stream contains fauna that may reflect the effects of drainage from pasture.

Cave contains protected species: *Micropathus cavernicola, Parvotettix goedei* and *Tasmanotrechus cockerilli*

Cave contains rare or threatened species: *Tasmanotrechus cockerilli*

Cave may contain other protected or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar*

Non-biological values: The cave is an important recreational cave. It contains speleothems and has a hydrological relationship to the Soda Creek system.

Internal threats: No serious internal threats to fauna identified, but there exists problems with trampling of fragile features and tracking of mud onto speleothems.

External threats: Catchment disturbance affecting the stream habitats and associated fauna.

Management issues: No serious internal biological management issues were identified, but the potential for the stream fauna to be an indicator of the effects of drainage from pasture should be recognised. The cave is a potential site to study these effects, and the 'health' of the Soda Creek karst drainage subsystem (of which King Solomons Cave is a part). The stream in Diamond Cave is also an important control point for monitoring water quality to assess the potential for pollution to be derived from the King Solomons Cave area. Water quality in Diamond Cave should be monitored at the same time as Soda Creek Cave following a tracer test to determine flow-through times (refer Section 3.4.4 below).

The principal cave visitor management issue confronting Diamond Cave is the tracking of mud and breakage of fragile speleothems. There is a need for some track marking with string lines. The mud problem occurs when people visit the muddy lower level passage then track the mud onto the speleothems in the upper levels on return. This degradation could be minimised by discouraging visitation to the lower level, and/or removing muddy clothing and boots after returning from the lower level.

Gating the entrance (or lower level) is one means of controlling the rate of degradation if this becomes unacceptable. The entrance of Diamond Cave may be located only a few metres outside the boundary of the King Solomons Cave Reserve if the fenceline accurately follows the surveyed boundary.

Recommendations:
- Undertake track marking to protect speleothems, and examine feasibility for cleaning.
- Install sign at the start of the lower level requesting removal of muddy clothing and boots upon return.
- Photo-monitor the degradation, and consider gating in the future if necessary.
- Monitor water quality, including nutrients, coliform bacteria, and other parameters as considered necessary.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Icona sp. (Tb)	SE coll. 1999
?Baalzebub sp.	SE coll. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
Stiphidiidae sp.	SE coll. 1999
?Anapidae sp.	SE coll. 1999
Opiliones sp. indet.	SE coll. 1999
?*Antipodeus* sp.	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Micropathus cavernicola	SE obs. 1999
Parvotettix goedei	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Collembola sp.	SE coll. 1999
Tasmanotrechus cockerilli	SE coll. 1999
Symphyla sp.	SE coll. 1999
Oligochaeta sp.	SE coll. 1999
Paludicola sp.	SE obs. 1999

3.4.4 Soda Creek Cave (MC18)

Land tenure: MCKNP/P?

Catchment status: Private, MCKNP

Biological values: Cave contains tree roots and troglobitic species. Cave is important for investigating the ecological effects of drainage from pasture, and potential pollutants (e.g. sewage, petroleum hydrocarbons) derived from the King Solomons Cave area.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli.*

Non-biological values: Cave is important for recreational users. Cave has a hydrological relationship to Soda Creek karst drainage subsystem.

Internal threats: No serious internal threats to fauna identified, as long as MIC practiced.

External threats: Catchment disturbance affecting the flow regime and water quality. Catchment includes pasture land and septic drainage from King Solomons Cave area. Potential for sedimentation, nutrient enrichment, organic and inorganic pollutants.

Management issues:
The principal management issues concern the monitoring and maintenance of water quality. Kiernan (1984) recorded high coliform bacteria levels in the cave stream, although the source may have derived from pasture land in the Loatta depression. Other potential pollutants include sewage derived from the King Solomons Cave area toilets and residence, and petroleum hydrocarbons derived from the road and carpark. Grey water from the residence is discharged directly into the karst. The toilets drain into septic tanks. All of these potential pollutant sources are situated very close to King Solomons Cave, and virtually overlying the Soda Creek karst drainage system. The potential for pollution from these sources to affect the Soda Creek Cave spring is considered quite high.

Considering the high potential for pollution of the karst groundwater system, water quality at this site should be periodically monitored. In addition, management strategies must be developed, and actions undertaken, to minimise the risk of pollutants entering the karst system from the identified sources within the MCKNP, and more widely elsewhere in the catchment. Whilst the Soda Creek Cave spring was dry during this survey, the aquatic macrofauna may be a potential indicator of pollution effects.

Recommendations:
- Monitor water quality, including nutrients, coliform bacteria, aquatic macro-fauna and other parameters as considered necessary.
- Develop and implement strategies to minimise risk of pollutants entering the Soda Creek karst drainage system from the identified sources within the MCKNP, and more widely elsewhere in the catchment.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
?Baalzebub sp.	SE coll. 1999
Amaurobiidae sp. (Tb)	SE coll. 1999
Stiphidiidae sp.	SE coll. 1999
Icona sp. (Tb)	SE coll. 1999
Araneae sp. indet.	SE coll. 1999
Opiliones sp. indet.	SE coll. 1999
Talitridae sp. (Ac)	SE coll. 1999
Styloniscidae sp. (Tb)	SE coll. 1999
Diptera sp. type 1	SE obs. 1999
Fulgoroidea sp. nymph	SE coll. 1999

3.4.5 Howes Cave (MC28)

Land tenure: Private

Catchment status: Private, State Forest

Biological values: Cave is important as stream inflow point with potential source of sediment, nutrients, and pollutants to Kubla Khan Cave. Cave stream and catchment has been subject to impacts including nutrient enrichment (droppings) and rubbish. Stream presently contains *Anaspides tasmaniae.* The cave contains tree roots.

Cave contains protected species: *Arachnocampa tasmaniensis, Micropathus cavernicola* and *Parvotettix goedei.*

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus*, *Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli.*

Non-biological values: Important for recreational users and has a hydrological relationship to Kubla Khan Cave.

Internal threats: No serious internal threats to fauna identified, as long as MIC practiced.

External threats: Catchment disturbance affecting the flow regime and water quality. Catchment includes pasture land with potential for sedimentation, nutrient enrichment and organic and inorganic pollutants.

Management issues: The principal management issue concerns maintenance of water quantity and quality entering Kubla Khan Cave through drainage from Howes Cave. The cave stream and catchment has been previously subject to impacts including nutrient enrichment (droppings) and rubbish. At the presumed point of appearance of the Howes Cave water in Kubla Khan Cave there are deposits of fine sediment, and in the perched sump pool there occurs a population of oligochaetes (density approximately 10 individuals per square metre) which might be an indicator of organic enrichment. This is a potential site to study and monitor the ecological effects deriving from Howes Cave and its catchment.

Additional water problems had the potential to occur when a dam construction was proposed in the creek bed immediately upstream of the entrance. This was avoided by siting the dam in another location, and managing the inflow and outflow of water from the dam. In addition, it is proposed to undertake some revegetation and control of blackberries in the creek bed (I. Houshold pers. comm.). For control of the blackberries, sprays suitable for use in watercourses should be used.

There is some rubbish accumulation inside Howes Cave, near the entrance, and in the creek bed immediately upstream of the entrance. The rubbish includes wood and metal drums. The potential for these drums to corrode and release pollutants into the water system needs to be assessed - removal may be desirable.

There is an old deposit of sheep droppings and weed infestation in one of the entrances to Howes Cave - at one time it appears the entrance was used as a kraal at which time sheep droppings would have moved down slope into the streamway. At times in the past, the water quality here may have been considerably reduced. The kraal no longer appears to be used and droppings entering the stream have now ceased, however future use of the entrance for stock shelter should be discouraged.

No serious issues relating to cave visitors were identified, however the cave contains tree roots vulnerable to damage. The roots and fauna may benefit from MIC techniques.

Recommendations:

- Assess the rubbish hazards in Howes Cave and catchment, and clean-up as necessary.
- Control blackberries, using sprays suitable for watercourses (e.g. Roundup Bioactive). Contact the DPIWE for more information on types of sprays and preferred alternatives.
- Confirm by dye tracing, the presumed hydrological connections with Girions Entry (MC41), Side Door (MC68), and Kubla Khan Cave.
- Monitor the water quality entering Kubla Khan Cave from Howes Cave. Include nutrients and coliform bacteria in the analyses. Include sampling under high flow conditions.
- Identify oligochaetes in the sump pool in Kubla Khan where the presumed water from Howes Cave enters.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Amaurobiidae sp. (Tb)	SE obs. 1999
Stiphidiidae sp.	SE obs. 1999
?Anapidae sp.	SE coll. 1999
Anaspides tasmaniae	SE obs. 1999
Arachnocampa tasmaniensis	SE obs. 1999
Micropathus cavernicola	SE obs. 1999
Parvotettix goedei	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Diptera sp. medium-fast type	SE coll. 1999
Aphididae sp.	SE coll. 1999
Gastropoda sp.	SE coll. 1999

3.4.6 Kubla Khan Cave (MC1)

Land tenure: MCKNP, Private

Catchment status: Private, MCKNP, State Forest

Biological values: Cave contains a diverse fauna, including troglobitic species.

Cave contains rare or threatened species: *Pseudotyrannochthonius typhlus, ?Hickmanoxyomma gibbergunyar, ?Tasmanotrechus cockerilli.*

Non-biological values: Cave contains outstanding speleothems, mineralogy, geomorphology and hydrology. Cave is important for recreational users including activities such as photography and cave diving.

Internal threats: No serious internal threats to fauna identified, as long as MIC practiced.

External threats: Catchment disturbance affecting the flow regime and water quality. Catchment includes pasture land with potential for sedimentation, nutrient enrichment and organic and inorganic pollutants.

Management issues: This section should be read in conjunction with the 1994 Kubla Khan Cave State Reserve Management Plan. In view of this earlier work, which included an intensive biological survey, this current survey did not re-examine Kubla Khan in great detail. However, a few comments are made below which should be read in conjunction with the section on Howes Cave (Section 3.4.5).

With respect to catchment management, the maintenance of water quantity and quality entering Kubla Khan Cave through drainage from Howes Cave, and other sources, is an important issue. At the presumed point of appearance of the Howes Cave water in Kubla Khan Cave there are deposits of fine sediment, and in the perched sump pool there occurs a population of oligochaetes (density approximately 10 individuals per square metre) which might be an indicator of organic enrichment. The worms were also observed to be present at least 12 months earlier. This is a potential site to study and monitor the ecological effects deriving from Howes Cave and its catchment.

There are other inflow points to consider, including the Grunter Swallets and drainage from south of Howes Cave (I. Houshold pers. comm.). In addition, there is a clear water inlet to the main stream just upstream of the sump in Cairn Hall - source unknown.

The 1994 management plan prescribes, as a high priority, the need to undertake hydrological and biological research and monitoring, particularly in relation to pollution of catchment streams.

No serious fauna issues relating to cave visitors were identified, however the cave contains riparian sediment banks and tree roots vulnerable to trampling or breakage. The habitats and fauna will benefit from MIC techniques.

One of the issues identified during preparation of the earlier management plan was the degradation of important habitat caused by cave visitors trampling logs and litter, and avalanching stones, down the steep slope below the lower entrance (MC1). To combat this a steel stairway was installed, and this has proved to be highly effective in eliminating the progressive degradation of habitat, as well as significantly reducing the amount of mud tracked onto formations lower down.

Recommendations:

- Confirm by dye tracing, the presumed hydrological connections with Girions Entry (MC41), Side Door (MC68), and Howes Cave, and cave streams to the south. Investigate the possibility of a connection with the Little Trimmer system.
- Monitor the water quality entering Kubla Khan Cave from Howes Cave. Include nutrients and coliform bacteria in the analyses. Include sampling under high flow conditions.
- Identify the oligochaetes in the sump pool in Kubla Khan where the presumed water from Howes Cave enters.
- Investigate by dye tracing, other inflow points to the Kubla Khan system, including drainage south of Howes Cave and the inlet near Cairn Hall.
- Seek identification and description of the earlier cave beetle collections made during the management plan survey - this material includes a possible new troglobitic species for Mole Creek. The specimens are currently in possession of Dr L. Genest in France (refer Section 2.1).

Fauna list: Refer to 1994 Kubla Khan Cave State Reserve Management Plan.

3.4.7 Genghis Khan Cave (MC38)

Land tenure: MCKNP

Catchment status: MCKNP

Biological values: Cave contains tree roots and troglobitic species.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli*

Non-biological values: Cave contains outstanding speleothems and mineralogy and has a genetic relationship to Kubla Khan. Cave is important for recreation including activities such as photography.

Internal threats: No serious internal threats to fauna identified, as long as MIC practiced.

External threats: No serious external threats identified, but the tree roots in the cave may be affected by high fire frequency or high fire intensity causing death of trees, and/or soil loss thus compromising tree regeneration.

Management issues: Refer to 1994 Kubla Khan Cave State Reserve Management Plan. In view of this earlier work, which included an intensive biological survey, this current survey did not re-examine Genghis Khan in great detail. However, no serious fauna issues relating to cave visitors were identified, although the cave contains tree roots. The habitats and fauna will benefit from MIC techniques.

Recommendations: None.

Fauna list: Refer to 1994 Kubla Khan Cave State Reserve Management Plan.

3.5 Mill Catchment

3.5.1 Croesus Cave (MC13)

Land tenure: MCKNP, State Forest

Catchment status: State Forest

Biological values: Cave contains aquatic troglobites in a percolation-fed streamway. Outside the lower entrance, the stream contains amphipods.

The terrestrial cave fauna is very sparse, being largely confined to the proximity of the entrances. A deep zone troglobitic fauna appears to be largely absent, although specimens of possibly troglomorphic diplurans (?*Campodea* sp.) have been collected previously (Eberhard *et al.* 1991) - this is the only record of such from Tasmania and hence may be significant. No terrestrial fauna was found during this survey, despite the existence of apparently suitable habitat of riparian sediment banks and potential food sources of platypus droppings, and a localised deposit of old wood at the Masterlock. The sparseness of fauna may be due to the absence of macro-particulate organic matter such as wood and leaves that would normally be carried underground by streams that are not fed solely by percolation water. In addition, the strong air currents between the upper and lower entrances may have a desiccating effect on terrestrial organisms.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli.*

Non-biological values: Cave contains outstanding gour dams, speleothems, geomorphology and hydrology. Cave is important for recreation including activities such as photography.

Internal threats: Possibly some potential for disturbance to aquatic fauna when visitors crawl along the small streamway leading from/to the upper entrance.

External threats: Catchment disturbance.

Management issues: No serious internal threats to cave fauna were identified, but the aquatic fauna in the small streamway leading to the upper entrance may benefit from MIC practices - viz. avoid crawling in the stream as much as possible.

Recommendations:

- Undertake further surveys for listed rare or threatened species, and other terrestrial troglobitic species, in Croesus Cave.
- Seek identification and description of the diplurans reported by Eberhard *et al.* (1991). Specimens are lodged at Queen Victoria Museum.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Antipodeus sp.	Eberhard et al. 1991
Eucrenonaspides sp.	Eberhard et al. 1991
Micropathus cavernicola	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
?*Campodea* sp.	Eberhard et al. 1991
Aphodius tasmaniae	A. Clarke pers. comm.
Chilopoda sp.	SE coll. 1999

3.5.2 Lynds Cave (MC14)

Land tenure: MCKNP, State Forest

Catchment status: State Forest

Biological values: The invertebrate cave fauna appears to be very sparse, being largely confined to the proximity of the entrances. The environment in the area of the upper entrances is very dry, probably due to the heating effect of the sun on the exposed cliff face - this will be a limiting factor to hygrophilic invertebrates. Somewhat surprisingly, a deep zone terrestrial troglobite fauna was not prevalent - none were found during this survey, despite the existence of apparently suitable habitat of riparian sediment banks and potential food sources of platypus droppings, and wood and leaves carried in by the stream. Upper entrance is used by bats and owls.

Cave may contain rare or threatened species: *Pseudotyrannochthonius typhlus*, *Hickmanoxyomma gibbergunyar* and *Tasmanotrechus cockerilli*

Non-biological values: Speleothems, geomorphology and hydrology; photography, recreation.

Internal threats: Access inside the upper entrance area for bats and owls has been compromised by the recent installation of a gate.

External threats: Catchment disturbance.

Management issues: Access for bats and owls inside the upper entrance area has been compromised by the recent installation of a gate. The area now gated is/was used occasionally by bats as evidenced by discarded prey of moth wings dropped from ceiling 'roost' sites. The bar spacing on the gate might still be large enough to permit access for bats, but flight entry is probably now more difficult and the bats may avoid the site. The consequences of this are unlikely to be crucial to the survival of the bats since it does not appear to be a permanent roost site as suggested by the lack of guano accumulations, and, the Tasmanian species are predominantly forest roosting. Usage of caves by bats in Tasmania is a generally rare phenomenon, but still of some scientific interest and conservation relevance when forest roost sites may be limiting. Contemporary usage of Honeycomb 2 Cave by bats was also noted during this survey. Cutting out a couple of the vertical bars in the gate at Lynds Cave may facilitate access for the bats. Although it should not be assumed that this action will negate the obstacle for bats entirely. There is some evidence that any kind of gate structure will interfere with bat flight movements to some degree (B. Cardinal pers. comm.).

It is not known to what extent if any, that the new gate interferes with the roosting of Boobook owls. There still remains some overhanging shelter on the outside of the gate, but a large portion of the twilight zone has been shut off by the gate. The bar spacing is large enough to allow owls to walk into (if they would do this), but not fly into/out-of the cave. The specific roost or nest site of the Boobook owl sighted during this survey was not located. An owl skull

was also found in one of the other entrances of Lynds Cave, beyond where it is now gated. Caves are evidently used by owls as roosting, and perhaps nesting, sites at Mole Creek, and elsewhere in Tasmania (e.g. Clarke 1999b). In addition to Lynds Cave, Boobook owls were sighted in Sassafras Cave and Honeycomb Cave during this survey. Boobook owls are not listed on the *TSP Act 1995*.

No serious internal threats to invertebrate cave fauna were identified.

Recommendations:

- Consider modifying the gate structure to facilitate access for bats and owls - monitor the effectiveness, or otherwise, of any actions undertaken.
- Ensure that an assessment of potential impacts on both vertebrate and invertebrate fauna is undertaken prior to gate design and installation.
- Undertake further surveys for listed rare or threatened species, and other troglobitic species in Lynds Cave.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
?*Baalzebub* sp.	SE coll. 1999
Acarina	SE obs. 1999
Opiliones sp. indet.	SE coll. 1999
Styloniscidae sp.	SE coll. 1999
Parvotettix goedei	SE obs. 1999
Micropathus cavernicola	SE obs. 1999
Diptera sp. type 1	SE coll. 1999
Diplopoda sp.	SE coll. 1999

3.5.3 Tailender Cave (MC64)

Land tenure: State Forest

Catchment status: State Forest

Biological values: The cave fauna appears to be fairly sparse, despite the existence of apparently suitable habitat for troglobites, with moist sediment banks and periodic flooding by the stream. However, near the sump was found a large population of Symphyla.

Cave contains protected species: *Micropathus cavernicola.*

Cave may contain other protected, rare or threatened species: *Pseudotyrannochthonius typhlus, Hickmanoxyomma gibbergunyar and Tasmanotrechus cockerilli.*

Non-biological values: Cave contains speleothems, geomorphology and hydrology. The upper level passage contains excellent speleothems. The cave is important for recreational users.

Internal threats: Speleothems in the upper level passage especially, have been extensively and unnecessarily muddied.

External threats: Catchment disturbance.

Management issues: No serious internal threats to invertebrate cave fauna were identified. The major issue concerns the tracking of mud onto speleothems in the upper level. There has been unnecessary duplication of pathways across flowstone surfaces, and unnecessary transfer of mud onto speleothems, resulting from careless caving practices in the past. Unfortunately most of the damage has already occurred. Protecting the formations is made difficult because the route involves stepping onto mud, then flowstone, then mud, flowstone and so on. Cleaning would be difficult although not impossible given the large pool of water nearby.

There is clearly a need in Tasmania for past attitudes towards what is acceptable in cave exploration practices to be updated and refined. Much of the degradation could have been avoided if the previous explorers had taken a little more care, and instigated conservation actions as they undertook their exploration.

Access to the upper level is not straightforward unless the pitch has been left rigged by a previous party. The original bolts remain in situ, but some climbing skills and equipment are needed to ascend the pitch. To reduce visitation levels, the pitch should not normally be left rigged. Removal of the bolts would make access much more difficult, but should only be done, if at all, after consultation with caving groups. Because most of the damage has already been done I feel that a better approach may be to involve caving groups in conserving and perhaps restoring what remains. This will help to foster a more careful attitude amongst the caving fraternity, which should encourage the appropriate protection of other sensitive sites as they are discovered in the future.

Recommendations:

- Investigate conservation and restoration of the upper level in consultation with caving groups.
- Undertake further surveys for listed rare or threatened species, and other troglobitic species.

Fauna List	**Recorded by**
Hickmania troglodytes	SE obs. 1999
Micropathus cavernicola	SE obs. 1999
Diptera sp. indet.	A. Clarke coll. 97-98
Diplopoda sp.	A. Clarke coll. 97-98
Symphyla	SE coll. 1999

PART 4 SUMMARY DISCUSSION AND CONCLUSIONS

A number of summary discussion points and conclusions resulting from this survey, and/or related to the primary tasks listed in Section 1.1, appear under separate sub-headings below.

Cave Fauna Management
No serious or urgent cave fauna management issues were identified within the Mole Creek Karst National Park at present. However, this does not suggest that management can be complacent as the surrounding intensive land use practices clearly indicate the potential for serious issues to develop. Of particular concern is the potential for these impacts to affect karst ecosystems through the water system. There is a need for vigilant monitoring of water quality, and development of ecological impact assessment studies. Some issues may remain unidentified during this limited survey.

Cave fauna conservation and management strategies should aim to protect, and restore where possible, the natural hydrological, soil and vegetation systems. Future management of cave fauna at Mole Creek must consider the distribution and conservation of protected and rare or threatened species that are located outside the reserved areas. Achieving both of these tasks will inevitably involve substantial interaction with neighbouring landholders and the local community.

Conservation Status of Cave Fauna Species
The conservation status of three species (*P. typhlus, H. gibbergunyar, T. cockerilli*) endemic to the Mole Creek karst and listed as rare or vulnerable under the *Threatened Species Protection Act 1995* has improved as a result of this project. The known distribution of these species has been extended to include other caves at Mole Creek, in particular the Marakoopa Creek karst drainage system that occurs in the WHA. However most of the known populations do not occur in reserved land.

Assessing the conservation status of the majority of the cave fauna species at Mole Creek is made difficult because it is undescribed. There is a need for taxonomic descriptions of undescribed material.

Recommendations:
- Change the conservation status of *Tasmanotrechus cockerilli* from vulnerable to rare under the *Threatened Species Protection Act 1995.*
- Maintain listing of *Pseudotyrannochthonius typhlus* as rare on the *Threatened Species Protection Act 1995.*
- Maintain listing of *Hickmanoxyomma gibbergunyar* as rare on the *Threatened Species Protection Act 1995.*
- Support taxonomic description of new troglobitic species at Mole Creek (and elsewhere in Tasmania).

Sensitive Habitats and Species
Cave fauna species and habitats at Mole Creek (and elsewhere in Tasmania) have an inherent resilience, perhaps more so than previously suspected, to both internal and external impacts. Evidence to support this supposition includes observations of 'healthy' cave communities existing in caves subjected to perceived threatening processes. These include large numbers of human visitors (e.g. Marakoopa Cave) and catchments subject to extensive clearing and modification of natural flow regimes and water quality (eg. Sassafras Cave). Other examples are cited for Ida Bay in Eberhard (1999).

There has been a widespread tendency in the past to over-emphasise and over-generalise the apparent sensitivity and vulnerability of karst ecosystems. In some cases these suppositions may be valid, but in other instances they may not be. The important point to emerge from my observations at Mole Creek and elsewhere, is to examine each site individually, and, not to jump to premature conclusions or make gross, over-simplistic and over-generalised statements concerning the sensitivity of cave fauna.

Habitat management in relation to cave visitor impacts in Tasmania is considered in detail in Eberhard (1999).

Internal threats
Cave visitors are not generally perceived to be a major threatening process to the survival of cave fauna species at Mole Creek. Whilst individual animals may occasionally be trampled underfoot, and individual cave populations may suffer some decline, or have areas of their habitat degraded, the impacts are extremely localised within the regional context of the species distribution range, and the spatial scale of the subterranean karst habitat. The distribution range of the identified species that are endemic to the Mole Creek karst appears to extend beyond single cave systems. In addition, there are vast areas of subterranean habitat, such as the mesocaverns for example, which form a permanent refuge from the direct impacts of human visitation. Note that this statement applies only to the identified species at Mole Creek. It should be borne in mind that the majority of the fauna remains unidentified and undescribed, and there

may exist species with more restricted distributions (e.g. single cave) and higher sensitivities - although none were detected during this very limited survey.

External threats
Threatening processes derived from outside the cave environment represent a potentially greater threat to the survival of cave fauna compared with cave visitors. These processes include catchment disturbance (land clearance, forestry, agricultural activities, and soil erosion), quarrying, water abstraction, and rubbish disposal which can impact karst ecosystems at gross spatial and temporal scales. There is a high risk of transfer and expansion of impacts through the water system (e.g. pollutants). The impacts may be serious and irreversible when whole catchments are affected. Future management strategies at Mole Creek need to focus on the external threats more than the internal threats.

Non-biological values
Cave visitors are a greater threat to non-biological values than to fauna in the Mole Creek Karst area. Extensive and irreversible degradation of speleothems has already occurred due to a lack of route marking, lack of education and poor caving practices.

Cave visitor ethics and Minimum Impact Caving
The conservation ethics and exploration practices of Tasmanian speleologists and cave visitors generally needs to be brought in line with modern standards, particularly because most cave degradation tends to occur on the first few trips into a cave. A sense of stewardship and duty of care towards fragile cave environments, as opposed to the 'underground gymnasium for fun and sport' type of attitude, needs to be promoted. In addition, a sense of responsibility to actively participate in rectifying inadequate route marking, or rehabilitating existing degraded areas, needs to be encouraged amongst the speleological fraternity. The attitudes and ethics of many Tasmanian speleologists is exemplary, but the Parks & Wildlife Service also has a responsibility to be actively involved with setting of standards and examples.

Recommendation:
- Promote education, route marking, restoration, and Minimum Impact Caving.

Interpretation
There is great potential for improved interpretation of cave fauna at various levels, especially given that the Tasmanian cave fauna is amongst the most species rich, most abundant and prevalent, as well as large (e.g. Tasmanian cave spider) and spectacular (eg. glowworms) in Australia. Tasmania is in a unique and enviable position to offer a quite different and dynamic natural feature for interpretation to the public. Most tourist caves have stalactites, but few have a large, spectacular and readily observable fauna. Cave fauna constitutes a significant part of the interpretation by guides at Newdegate Cave, Hastings for example.

Interpretation of the fauna can serve the dual purpose of:
1. Providing a stimulating and entertaining experience to the public.
2. Educating the local community and public at large, increasing awareness and fostering conservation of cave fauna.

Cave fauna is presently interpreted to the public by cave guides, through the wildlife fact sheets on 'cave creatures' and 'cave ecology', and interpretive signs at Hastings and Junee. In addition, cave fauna was featured in displays at an agricultural festival in 1998 (Agfest). It has also been proposed that the cave fauna fact sheets will be put on the Parks & Wildlife Service web site. However, the Parks & Wildlife Service has a responsibility to deliver accurate and high quality interpretation material. There is considerable scope in this regard, for the Parks & Wildlife Service to improve its present interpretation, and to develop new material and media. There is considerable information on cave fauna that can be used in interpretation, collated in Eberhard (1999). Cave fauna can be interpreted in a number of different ways, including for example:

- by guides on the cave tours;
- the cave fauna fact sheets;
- through photographs, etc at interpretation centres;
- through school education programs;
- through displays (e.g. Agfest);
- posters and public talks;
- through newspaper, magazine, and other audio-visual media;
- world wide web.

Recommendation:
- Further refine existing interpretation, and develop new interpretation of the highest quality and accuracy.

Future Work

There are at least three major directions for future cave biological work at Mole Creek. Firstly, there is a need for further taxonomic work as much of the fauna remains undescribed. Many of the undescribed species would qualify for listing as rare or threatened. There is now a reasonably good baseline characterisation of the Mole Creek (and other Tasmanian) cave fauna (refer Eberhard *et al.* 1991). The next step in the process is to get this material described so that conservation needs can be assessed. In the absence of other potential proponents, the Parks & Wildlife Service has a responsibility to continue pursuing and supporting the taxonomic process. Section 2.4 of this report highlights some of the groups in need of taxonomic treatment.

The second future research direction involves ecological impact assessment studies, particularly relating to the water system where the greatest potential threats lie. There is a need for vigilant monitoring of water quality, and characterisation of the ecological aspects to this. This will require identification and description of the aquatic species and communities, and studies of their response to various perturbations. The subterranean fauna is likely to prove useful as a bio indicator of water quality aspects.

Thirdly, there is a need to extend the baseline fauna surveys and assessment of potential impacts to caves located outside the Mole Creek Karst National Park. This is especially important in view of the multiple land tenures, land uses, and potential impacts occurring within the same catchments and karst drainage subsystems. The present survey was more or less confined to caves within the MCKNP, which represents only a small proportion of the Mole Creek karst. Sample sites need to be prioritised and possibly stratified, with all catchments and karst drainage subsystems adequately represented.

In addition, very little baseline data is available for the Mersey Hill and Dogs Head catchments. High priority should be accorded to surveys of these catchments. The Parks & Wildlife Service should seek to acquire representative reserves or conservation agreements within these catchments. Likewise, the groundwater habitat of the Den Plain area is different to the stream cave habitats generally found elsewhere at Mole Creek - a specialised groundwater fauna is known to occur (Eberhard *et al.* 1991). This area needs to be examined more thoroughly, especially in view of the high potential for groundwater pollution and over abstraction.

There are likely to be other important management and research priorities aside from those outlined above. More specifically, a number of potential fauna research/management projects have arisen through the recommendations of this report. These are listed below in no particular order of priority. The list should not be considered at all comprehensive, nor should each specific recommendation necessarily be undertaken. The list is intended simply to initially guide and stimulate further research. Further work is required to prioritise and more clearly define future research directions.

Species oriented projects

Search for *Tasmanotrechus cockerilli* in the Mill Creek, Dogs Head and Mersey Hill catchments.

Confirm by expert identification and/or genetic studies, the discreteness or otherwise, of different cave populations of *Tasmanotrechus cockerilli* .

Search for *Pseudotyrannochthonius typhlus* in the Mill Creek, Dogs Head, and Mersey Hill catchments.

Support taxonomic redescription of *Pseudotyrannochthonius typhlus*.

Search for *Hickmanoxyomma gibbergunyar* in the Loatta, Mill Creek, Dogs Head, and Mersey Hill catchments.

Support taxonomic description of subterranean Amphipoda from Mole Creek (and elsewhere in Tasmania). Contact Dr John Bradbury (University of Adelaide).

Support taxonomic description of subterranean Phreatoicidea from Mole Creek (and elsewhere in Tasmania). Contact Dr George Wilson (Australian Museum).

Support taxonomic description of subterranean Hydrobiidae from Mole Creek (and elsewhere in Tasmania). Contact Dr Winston Ponder (Australian Museum).

Support taxonomic description of subterranean Pseudoscorpionida from Mole Creek (and elsewhere in Tasmania). Contact Dr Mark Harvey (Western Australian Museum).

Support taxonomic description of subterranean Araneae from Mole Creek (and elsewhere in Tasmania). Contact Dr Mike Gray (Australian Museum) or others.

Support taxonomic description of subterranean Collembola from Mole Creek (and elsewhere in Tasmania). Contact Dr Penny Greenslade (CSIRO Division of Entomology) or others.

Seek identification and description of the earlier cave beetle collections made during the management plan survey - this material includes a possible new troglobitic species from Kubla Khan. The specimens are currently in possession of Dr L. Genest in France (refer Section 2.1). For taxonomic description of subterranean Coleoptera from Mole Creek (and elsewhere in Tasmania) contact Dr Barry Moore (CSIRO Division of Entomology) or others.

Support taxonomic description of other subterranean groups from Mole Creek (and elsewhere in Tasmania), including: Syncarida (*Anaspides* and *Eucrenonaspides*), Enicocephalidae, Diplura, Opiliones and others.

Collect and identify the oligochaetes found in the sump pool in Kubla Khan where the presumed water from Howes Cave enters.

Identify the oligochaetes found in Diamond Cave, where the drainage is derived from pasture land.

Cave, catchment, or community oriented projects
Develop a water quality monitoring and assessment program, which includes macro-fauna, nutrients, coliform bacteria, toxins, other pollutants and physicochemical parameters as considered necessary.

Undertake baseline fauna survey and assessment of potential impacts in the Mersey Hill and Dogs Head catchments.

Undertake baseline fauna survey and assessment of potential impacts in caves located outside the Mole Creek Karst National Park. Prioritise and stratify sample sites - include all catchments.

Undertake fauna survey and assessment of sensitive habitats in Devils Pot, Devils Earhole, Marakoopa 2, and other unsurveyed caves in the Marakoopa Creek drainage system.

If the water supply system at Westmorland Cave is altered then empirical evidence of the resultant ecological changes, if any, should be obtained. This needs to be undertaken as a properly designed BACI (Before-After-Control-Impact) study.

Maintain and monitor the fauna sanctuary near the main entrance (MC32) of Baldocks Cave.

Consider installing a fauna sanctuary at the side entrance (MC33) of Baldocks Cave, and monitor the recovery or otherwise of fauna.

Monitor the water quality and aquatic macro-fauna in Howes Cave and Kubla Khan Cave. Include macro-fauna species, nutrients, coliform bacteria, and other parameters as considered necessary. Include sampling under high flow conditions.

Monitor water quality and aquatic macro-fauna in Diamond Cave and Soda Creek Cave. Include macro-fauna species, nutrients, coliform bacteria, and other parameters as considered necessary. Include sampling under high flow conditions.

Undertake further surveys for listed rare or threatened species, and other terrestrial troglobitic species, in the Mill catchment. Search in Croesus Cave, Lynds Cave, Tailender Cave, Rat Hole, and others.

Seek identification and description of the diplurans reported by Eberhard *et al.* (1991) from Croesus Cave. Specimens are lodged at Queen Victoria Museum (contact Dr Tim Kingston or Tammy Gordon).

Consider modifying the gate structure in Lynds Cave to facilitate access for bats and owls - monitor the effectiveness, or otherwise, of any actions undertaken.

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