Bat Colonies in the Hamersley Range Asbestos Mines.

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Background

Crocidolite asbestos occurs as seams in the banded iron formations of the Hamersley Range where it was mined between 1933 and 1966. Two features of its occurrence that influenced mining methods were the exposure of seams on the sides of many of the gorges and their "flat lying attitudes". Mining methods have varied from knapping the exposed seams and developing narrow benches to complex stooping in extensive underground mines (Trendall and Blockley 1970).

The underground mines are dangerous for two reasons: Firstly the health hazards associated with crocidolite are high. Secondly many of the roofs of shafts are extremely unstable. Nevertheless the area is a tourist Mecca and these old mine shafts invite exploration by passers-by who may not realise the dangers. The Western Australian Government wishes to close off the shafts to protect would-be explorers and has commissioned the design of appropriate structures (Metplant Engineering Services 1995). However occlusion could pose a threat to populations of bats that may roost in the mine shafts. Bats can be accommodated by carefully designed grills set into these structures.

Whilst underground mines can provide roost sites for cavernicolous bats, the quality of the sites (and hence their value to bats) depend on both the micro-climate in the mine and the bats' physiological requirements for climatic factors in roosts. Temperature and humidity are important climatic factors that are controlled by structural features including depth, aspect and air flow as well as physical features including geology and hydrology. In complex mines micro-climates may vary extensively within the mine. Different bat species vary considerably in their requirements for humidity and temperature in the roost. Some tolerate low humidity and considerable temperature fluctuation and posses behavioural response capacities that help the animals to seek out the optimal situations within roosts. Others are less tolerant of these factors.

Table 1. The five cavernicolous bat species known to live in the Pilbara, their status and their roost requirements.

Species	Status	climatic tolerance in roost
Macroderma gigas Ghost Bat	uncommon	requires high humidity and temperature
Rhinonycteris aurantius Orange Horseshoe Bat	Schedule 1 gazetted rare	requires high humidity and temperature
Taphozous georgianus Common Sheath-tailed Bat	common	tolerates wider range of humidity and temperature
Taphozous hilli Hill's Sheath-tailed Bat	common	tolerates wider range of humidity and temperature
Vespadelus finlaysoni Finlayson's Cave Bat	common	tolerates wider range of humidity and temperature

Objectives

It is important to provide for bats where rare species or large numbers occupy shafts that are to be closed. Our objective was to determine the species present and the size and importance of the colonies in each of the mines. With that knowledge we can identify shafts that require bat-grills built into closing structures and provide specifications that meet the requirements of the bat species using the mine.

Methods

a) Field Program

The field survey was carried out by A.N. Start and N.L. McKenzie of CALM Science and Information Division between 8 -20 January 1996.

b) Equipment.

- Light for underground work was provided by "Petzl" electric head torches, usually using Quartz-halogen bulbs.

- A hand-held net was used to capture bats while searching some shafts.

- Two harp traps manufactured by AUSTBAT were set up at mine portals to capture bats entering or leaving shafts during the night. Harp traps were also used in areas near the mines, particularly over water, to check for the presence in the area of cavernicolous species that were not located in the mines.

- Mist-nets (more-readily detected than harp traps by some bats, including orange horseshoe bats) were used within shafts where they could totally block access to deeper workings. They were set in V-formations which have proved effective for orange horseshoe bats (and the other cavernicolous species) in other Pilbara mines. Mist nets were also used in areas near the mines, particularly over water, to check for the presence in the area of cavernicolous species that were not located in the mines.

- While searching most mine shafts we carried "Anabat" bat detectors. Ultrasound calls of ghost bats and orange horseshoe bats are distinctive and different from other cave-dwelling species in the Pilbara (Table 2).

- Bat movement in and out of some shafts was monitored throughout the night by linking the bat detectors via "Anabat" automatic switches (which are triggered by signals registered by the bat detectors) to Sony Professional Walkman tape-recorders. Tape recordings of bat passes were analysed later. Bat detectors were set inside shafts but near the entrances so that any bats entering or leaving the mines by that portal during the night had to pass within a couple of meters of them. On one occasion the detectors were triggered by crickets that lived in the twilight zone. Thereafter they were placed far enough into the mine entrances to avoid false-triggering by crickets.

Table 2. Free-flight echolocation call characteristics of the mine- and cave-dwelling microchiroptera that occur in the Pilbara.

Species	Shape[a]	Freq[b]	N[c]
Rhinonycteris aurantius	CF-FM	123-127	5
Vespadalus finlaysoni	st-FM	52-55	6
Taphozous georgianus	sh-sh-FM	24-25.5	6
Taphozous hilli	sh-sh-FM	24-26	6
Macroderma gigas	sh-FM	55.5-56.5	2
" "	st-st-FM	33-58 5 [d]	4

a FM = frequency modulated; st-FM = steep-sweep FM; sh-FM = shallow-sweep FM; CF-FM = constant frequency, with a brief period of FM at ends of the call.
b Frequency (Khz) of shallowest part of frequency sweep (normally = lowest frequency in FM calls).
c N = number of bats.
d Minimum to maximum call frequency values (frequency sweep has no shallow part).

c) Location of shafts.
We had a copy of a report and maps (Metplant Engineering Services 1995) showing the entrances to each known shaft at three mines. On the maps they were numbered 1-38 (Table 3). In the field each portal had a number painted on the adjacent rock face which corresponded to the numbers on the maps. At the Colonial Mine a few stoop workings opened onto the cliffs above the shaft portals. Those entrances were not marked on the maps, were inaccessible from outside without specialised climbing equipment and, we understand, will be left open (BMA Engineering, personal communication).

Table 3. The location of mine shafts detailed in Metplant Engineering Services 1995

Shaft numbers	**Mine name**	**Location**
Shafts 1-6	Wittenoom Mine	Wittenoom Gorge
Shafts 7-20	Yampire Mine	Yampire Gorge
Shafts 26-38	Colonial Mine	Colonial and (26) Western Gorge
Shafts 21-25	Colonial Mine Annex[1]	Western Gorge

d) Techniques (See Appendix 1 for a summary)

- **Yampire Mine.** At the Yampire Mine all shafts were searched visually with head-torches. This was adequate for all the shallow shafts. Shaft 16, with a short side branch (shaft 17), was about 30m long. A bat detector was carried whilst searching it. The most complex system had three entrances (shafts 7, 9 and 10). We set harp traps and a bat detector linked to a tape recorder over night to cover these entrances

- **Wittenoom mine** At the Wittenoom mine all shafts had ceilings that were extremely unstable. We did not enter Shaft 6 where the entrance had partly collapsed, but followed the others for at least 100m, as far as we deemed it safe. Most, if not all, of the shafts inter-connected within the mine and so bats would be

[1] treated by Metaplant (1995) as part of Colonail Mine but not connected to tho Colonial mine shafts.

able to use any one of the entrances (except that shaft 4, which joined shaft 2 within about 10m of the portal, was closed off by a door). We used harp traps, detectors linked to tape recorders and a mist net to cover each of the shafts simultaneously one night. The net was tended until about 21.00hrs by which time bats would probably have left the roost. (Mist nets were not left overnight because bats soon chew their way out.) The other equipment was left overnight

- **Colonial Mine.** At the Colonial Mine the explosives magazine (shaft 28) was blocked by a locked door but was shallow and could be inspected fairly thoroughly from outside. Shaft 29 was a shallow store and was searched visually. Shaft 36 was a shallow drive housing conveyor equipment below the main drive. It was searched visually.

  We spent 14 or 15 hours underground searching deeper shafts in so far as we deemed it safe to do so. While searching deeper shafts we carried a bat detector and sometimes a hand net. We:

a) followed the main drive (shaft 35 which housed the conveyor belt) which dipped on a gentle gradient to about the "eighth level" where it intersected the water table and was flooded.
b) followed passageways in the system above the main drive (carrying the rail lines that linked shoots from the mine stoops above to the main conveyor below) to exits (shaft numbers 26, 29/30, 31, 32 and 38) From shafts 29/30 we followed Adit 3 to the water table. Shaft 38 was a vertical air shaft. Ladders in it appeared unsafe and so we did not exit the portal but had a clear view to daylight. We did not locate shaft 37 but did locate strong air movement into a stoop area between 26 and 37. Further exploration to locate that portal was prevented by dangerous conditions.
c) explored many of the other internal rail passages, rooms etc on that level.
d) searched several of the stoops above the rail system including some that dipped to the water table.

  We placed bat detectors linked to tape recorders and ran them overnight at most of the entrances to the deep shafts.

- **Colonial Mine Annex.** At the Colonial Mine Annex (see footnote to Table two) all the shafts (21-25) were shallow and easily searched visually.

- **Non-mine sites.** In Yampire Gorge and in Kalamina Gorge we set mist nets and harp traps to see whether cavernicolous bats that we had not encountered in the mines were nevertheless resident in the area. In Yampire Gorge we also spent some time collecting bats with the use of a shot-gun and spotlight.

Results.

Yampire Mine. *V. finlaysoni* and *T. georgianus* were roosting in Shaft 16 and the shaft 7/10 chambers. Several sought temporary refuge in the shallow shafts when disturbed from 16. Total numbers for each species probably did not exceed 30. Non-flying juvenile *V. finlaysoni* and very young flying *T. georgianus* were present Thus these mines are used for breeding. One lesser long-eared bat, *Nyctophilus geoffroyi* was caught in a harp trap at entrance 10. This species does not usually use caves as roosts and was probably caught as it foraged along the cliff face.

Wittenoom Mine. *V. finlaysoni* and *T. georgianus* were seen in the entrances (mostly in sight of daylight) of shafts 1-5 where they were also caught in a harp traps, and a mist net as well as being detected on tape. *V. finlaysoni* was recorded on tape at the entrance to shaft 6. The total population probably did not exceed 50 individuals of each species. Immature individuals and lactating female *V. finlaysoni* suggest that this is a breeding site.

Colonial Mine. *V. finlaysoni* and *T. georgianus* were seen in the entrances (mostly in sight of daylight) of all shafts. Their abundance decreased with distance from the outside and they were rare more than 200m in the mine, Small accumulations of bat droppings indicated occasional use of deeper sites, such as the vertical ore shoots, by some bats at other times. Given that the mine has not operated for almost 30 years the small size of the accumulations indicates that these are not regular or large roosts. At the time of our visit the total population probably did not exceed one hundred individuals of each species. Non-flying juvenile and lactating female *V. finlaysoni* and a long-dead immature *T. georgianus* suggest that this is a breeding site.

Colonial Mine Annex. *V. finlaysoni* and *T. georgianus* were seen in the deeper parts of this shallow set of workings. The total number did not exceed ten bats of each species.

Non-Mine sites. We did not catch any bats in Kalamina Gorge. Table 4. lists the species we caught or shot in Yampire Gorge.

Table 4. Bat species recorded in Yampire Gorge at sites other than the asbestos mines.

Family	Species	Abundance	Usual roost site
Emballonuridae	Taphozous georgianus	common	cave/rock crevice
Emballonuridae	Saccolaimus flaviventris	occasional	tree
Molossidae	Chaerephon jobensis	common	tree
Molossidae	Mormopterus beccarii	occasional	tree
Vespertilionidae	Chalinolobus gouldii	common	tree
Vespertilionidae	Scotorepens greyii	common	tree

Conclusions.

Two species of bats, *V. finlaysoni* and *T. georgianus,* occurred in all of the mines and used them for breeding. These species are common in small caves in the Pilbara. Colonies usually number in the tens. Colony size is probably allied to availability of suitable roosts and the characteristics of the caves. These colonies were average to large. Both these species tolerate a broad range of micro-climatic roost conditions.

It would be highly desirable to fit grills to shaft 7 in Yampire Gorge and to shafts 26 and one other in the Colonial mine as well as two shafts (but not shaft 6 where the entrance is collapsing or shaft 4 unless the door 10m inside the portal is removed) in the Wittenoom Mine. There would be little benefit from a bat grill in the Colonial Annex, (Shafts 21-25). The grill specifications are detailed below.

Three cavernicolous species known from the Pilbara were not located. As far as is known *T. hilli* has roost requirements similar to *T. georgianus* and it has been taken from an adit at Marandoo which it shared with that species (Kitchener 1980). However *T. hilli* would be close to the northern limit of its range in the asbestos mines. It is not a rare species and if it does occasionally use the mines, the recommended grills would accommodate it.

Given the extent of the mines and hearsay rumours we expected to find ghost bats, *M. gigas*. Ghost bat roosts are characterised by piles of large droppings intermixed with refuse from prey, including bat wings, bird feathers, rodent tails etc. They are obvious and unmistakable. We found no trace of these signs. Ghost bats are also readily detected by experienced observers as they fly along passages or leave roosts. They require high temperatures and high humidity in their roosts. In the arid Pilbara warm, humid spots are usually found in domed chambers where warm air can be trapped. All the shafts and stoops we searched had dry atmospheres. In the large Colonial Mine the shafts followed the dip of the rock strata downwards so that warm humid air from places where the shafts intersected the water table would flow up and out during the cool nights. These mines probably do not afford adequate micro-climatic conditions for ghost bat roosts.

Orange horseshoe bats, *R. aurantius*, are known from very few roosts in the Pilbara. In all of them ghost bats are also present. Like the ghost bats, they require high humidity and temperatures but they are probably more demanding of these criteria. Given that we found no evidence of ghost bats and think that is because the micro-climate is unsuitable we do not expect the mines to be important roosts for this species.

It is possible that amongst the very extensive stoop workings of the Colonial Mine there may be pockets that provide roosts for ghost bats or orange horseshoe bats. If so they are apparently using the exits high above the mine portals. Those exits are not to be filled in and so bats using them will not be affected.

Recommendations

A grill, as specified below, be fitted to the barrier walls erected at the entrance to Adit 7 (Yampire Mine), Adits 26 and 31 (Colonial Mine), and Adit 2 and 1 (Wittenoom Mine).

Specifications for bat grills suitable for the asbestos mines.

There are various designs for bat grills at entrances to mine workings (see for example taylor 1995). The following will be adequate for these mines. A panel of galvanised steel weld mesh. The mesh gaps to be a minimum of 300mm wide and 150mm high. The rod to be at least 7mm diameter. Each panel to be a minimum of 1500mm wide and 600mm high. The panel should be set into the concrete barrier at least 1000mm above the floor of the adit, and the concrete sill beneath the frame should slope steeply (45° or more) down on both sides of the barrier so that it does not provide a horizontal platform from which a cat or other predator could easily leap.

References

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Appendix 1. Summary of the methods used to locate bats in each shaft.

Mine	Shaft	Depth	Visual search	other methods
Wittenoom	1	deep	limited	detector with auto-switch
Wittenoom	2	deep	limited	harp trap
Wittenoom	3	deep	limited	mist net
Wittenoom	4	deep	limited	blocked (links to 2)
Wittenoom	5	deep	limited	detector with auto-switch
Wittenoom	6	deep	no	detector with auto-switch
Yampire	7	deep	thorough	harp trap
Yampire	8	shallow	thorough	nil
Yampire	9	deep	thorough	detector with auto-switch
Yampire	10	deep	thorough	harp trap
Yampire	11	shallow	thorough	nil
Yampire	12	shallow	thorough	nil
Yampire	13	shallow	thorough	nil
Yampire	14	shallow	thorough	nil
Yampire	15	shallow	thorough	nil
Yampire	16	moderate	thorough	nil
Yampire	17	moderate	thorough	nil
Yampire	18	shallow	thorough	nil
Yampire	19	shallow	thorough	nil
Yampire	20	shallow	thorough	nil
Colonial Annex	21	shallow	thorough	nil
Colonial Annex	22	shallow	thorough	nil
Colonial Annex	23	shallow	thorough	nil
Colonial Annex	24	shallow	thorough	nil
Colonial Annex	25	shallow	thorough	nil
Colonial	26	very deep	extensive	detector with auto-switch
Colonial	27	shallow	thorough	nil
Colonial	28	shallow	thorough	nil
Colonial	29	very deep	extensive	detector with auto-switch
Colonial	30	very deep	extensive	detector with auto-switch
Colonial	31	very deep	extensive	detector with auto-switch
Colonial	32	very deep	extensive	detector with auto-switch
Colonial	33	?	not found	not mapped by Metplant
Colonial	34	?	not found	not mapped by Metplant
Colonial	35	very deep	extensive	nil
Colonial	36	moderate	very deep	nil
Colonial	37	very deep	not seen	nil
Colonial	38	very deep	extensive	nil