Vets Celia Dickason (PIRSA) and Dr David McLelland (Adelaide Zoo) removing ulcers from bats.

BAT RESEARCH AT NARACOORTE

– Steve Bourne

INTRODUCTION

The population decline of the Southern Bentwing Bat *Miniopterus schreibersii bassanii* at Bat Cave, Naracoorte has been well documented through various reports over the past decade (for a comprehensive list of references relating to work on this species, see Kerr & Bonifacio 2009). The research program has sought to identify factors that may have contributed to this decline, but to date, nothing conclusive has been determined. One of the greatest challenges has been trying to ascertain what the actual total population of the species is. A fundamental problem with determining this is a reliable method of accurately counting all of the bats at any given time. A possible causal factor for the decline is loss of habitat, but this is difficult to confirm when we do not even know their favoured feeding grounds.

Although the majority of bats spend the summer months in Bat Cave, where they spend winter is less well known. There are over 60 known caves that have been used. A project was funded by the Wildlife Conservation Fund to undertake a survey of winter cave sites. The Department for Environment and Heritage also received funding from the South East Natural Resources Management (SE NRM) Board to support bat conservation work. This enabled a Project Officer, Ronald Bonifacio to be employed which enabled a great deal of work to be completed in a short period of time. The Friends of Naracoorte Caves received a grant to investigate foraging habitats by radio tracking from the World Wide Fund for Nature through the Threatened Species Network. An outbreak of disease detected when the bats returned to Bat Cave in spring sparked an intense investigation. This paper describes work undertaken over the past six months in the quest to conserve this species.

A close up of an ulcer being removed.

Anaesthetising bats is a delicate process!

DISEASE OUTBREAK!

In early September, one of the Naracoorte Site Interpreters, Decima McTernan, reporting seeing something that appeared to be an ulcer on an adult bat. I spent quite some time viewing footage through the permanent infra red cameras installed in Bat Cave, but failed to see anything like Decima reported. A visit was made into the cave for a closer inspection to determine whether this was a single occurrence or something more sinister. The cave visit raised serious concerns as over 50% of the bats inspected had white raised ulcers 1-2mm across, all on bare skin. I contacted people who had previously been involved with the December 2008 investigation into lesions found on pups and received an excellent response. Ten bats were caught and sent to Adelaide for emergency testing.

Investigations were undertaken by Dr David McLelland from the Adelaide Zoo. All bats were caught in a side chamber away from the main maternity area which may have biased the sample, I managed to catch 10 males! The initial analyses identified parasites were responsible for the majority of ulcers with one attributed to a pox virus. This is particularly significant as pox viruses, as far as we could determine, had not been previously found in bats. Samples were submitted to the Australian Animal Health Laboratory in Victoria, Gribbles Laboratory and to a parasitologist Dr Ian Beveridge at Melbourne University.

On 26 October, David and Dr Wayne Boardman from the Adelaide Zoo, Celia Dickason from PIRSA and Terry Reardon from the South Australian Museum travelled to Naracoorte to undertake further investigations. Rather that euthanasia, operations were conducted under anaesthesia – a particularly delicate exercise! We trapped 125 bats and operated on 18. Interestingly, ulcers were more prevalent on male bats with females generally pregnant and healthy. Very pleasingly, the percentage of bats with ulcers was much less and they were generally less severe that were observed a month earlier. Since this investigation, only occasional observations of ulcers have been made through the cameras and no fatalities that could be attributable to them found. A visiting expert to Adelaide offered a possible identification of the parasite, *Riouxgolvania beveridgei*, which was described in 1965 from specimens found in *Miniopterus* in North Queensland (Bain, 1979). It was a great effort to track down the paper (in French) describing the parasite and to discover the holotype was held in the South Australian Museum!

These investigations were generously supported by PIRSA who treated the outbreak as a biosecurity risk. The support from Adelaide Zoo vets, testing laboratories and universities was outstanding and an excellent network has been established should the need arise again.

In 2006, pup mortality was high with the dry season suggested as the cause (Bourne & Hamilton-Smith 2007). The 2008 season saw similar mortality but some pups had lesions as well as malnutrition. We had people in place should similar symptoms arise this season but 2009/10 has been a more successful season than the previous three years. The risk of mortality from disease appears to have abated for the time being.

The thermal imaging camera attached to the fence and the mini DV video recorder on the tripod showing how the equipment is set up.

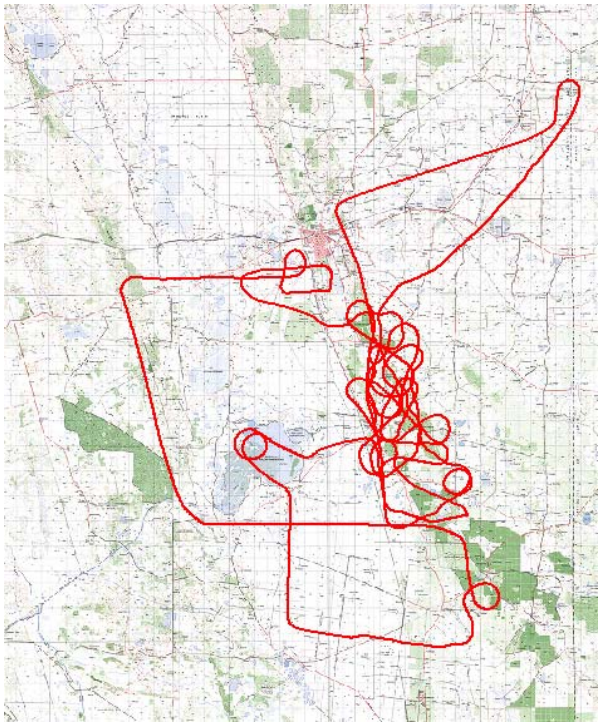
DETERMINING THE POPULATION OF SOUTHERN BENTWING BATS

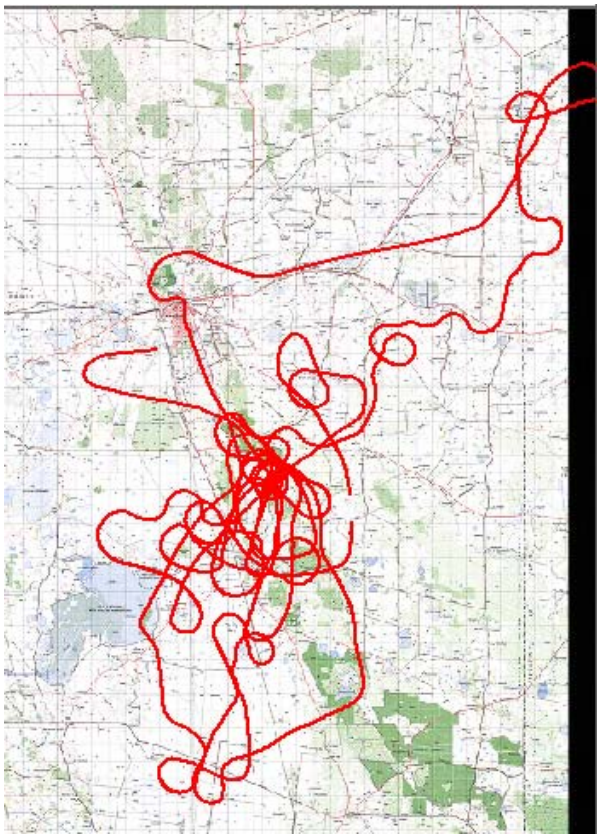
Southern Bentwing Bats only breed at two sites, Bat Cave at Naracoorte and Starlight Cave at Warrnambool. It was reported in 1965 (Dwyer and Hamilton-Smith) that unlike other species of *Miniopterus*, males return to the maternity site over the summer months. This has not been tested since and it has been assumed that if this is the case, a count of bats at Bat Cave during summer will include the entire South Australian population. It is now known however, that all bats do not return to Bat Cave, with up to several thousand bats found in what have traditionally been called 'wintering sites' over summer (Chris Grant pers comm.). This calls into question the validity of Bat Cave counts as an accurate population census. What we have really been counting each year is the number of bats in Bat Cave without checking where the entire population is!

Video counts have been completed annually by Chris Grant, a laborious but reasonably accurate process. The counts show a steady decline from 35,000 in 2000 to 21,000 in 2008, a reason for serious concern. There are two important factors to consider and this very low figure should be treated with caution.

- It is difficult to determine if all the bats have left the cave. The permanent cameras do not show all chambers and a physical check was not done.
- There was no check of other cave sites for bats. There could have been thousands elsewhere as has been observed previously.

When the counts were undertaken in 1965 by Dwyer and Hamilton-Smith, the district had been through a number of extremely good seasons, in fact 1964 was the wettest year on record (880 mm) for Naracoorte. Good wet seasons would produce an abundance of food and the entire population could be supported living in Bat Cave. The 2008 count followed a number of dry seasons with 2006 the driest year (234mm) on record).





Maps showing the flight path of the plane on successive nights. Each map covers approximately 25km across. Bat Cave is just right of the map's centre.

It is speculative, but it is possible food resources are substantially lower in the dry periods and male and non breeding females may use caves elsewhere to enable breeding females to utilise resources closer to Bat Cave. This will be discussed further under determining foraging habitat.

Although we cannot be sure of how much of the population we are counting when counts are undertaken at Bat Cave, accurate counts are nevertheless important. How many bats are using the cave and how successful is each breeding season? Terry Reardon has been working closely with Adelaide-based company Lastek to develop an automated counting system.

This involved placing a thin sheet of light across the cave entrance and using light sensitive diodes to record each time the sheet of light was broken. This project was progressing slowly with mixed results when the possibility of using thermal imaging technology became an option.

The Department for Environment and Heritage secured a grant through the South East Natural Resource Management (SE NRM) Board to undertake some bat work which included elements previously unsuccessfully submitted for Caring for our Country funding. This grant included wintering site survey and protection works, equipment to count the bats and data loggers to monitor in cave conditions.

Terry Reardon in the Fossil laboratory with radio tracking and thermal imaging equipment.

THERMAL IMAGING

We learnt that Doug Mills had a thermal imaging camera in New South Wales and had software to count bats. We brought Doug to Naracoorte and conducted a trial. All were quickly convinced that this technology was what we were looking for, a system that could be easily set up and once calibrated provide accurate counts that did not require days of laborious counting.

The technology we are using was developed by the US military for missile tracking. It was adapted for bat counting by Bruce Sabol and Eddie Menton of the US Army Engineer and Research Development Center and is called the Thermal Target Tracker (T3) System. Thermal infrared is a passive sensing technique that takes 'heat pictures' by measuring heat radiated by objects. No illumination is required and the resolution of the camera is such that a bat's body heat is detectable against relatively cooler backgrounds. The continuous flight motion of the bat allows each individual bat to be tracked from frame to frame using the bat's instantaneous motion vector to predict and detect its position in the next frame (Sabol & Melton, 2008).

Cool objects are dark and warmer objects lighter with more accurate counts gained with greater contrast between background and the objects

being counted. To cool the background, hessian has been used and is soaked with water prior to the count. This gives an almost black background against which the bats appear quite white. Two Photon 320 NTSC cameras were purchased, a 19 mm wide angle and 35 mm lens. We purchased the highest resolution cameras that the US Military allow to be exported from the US and waited over five months for them to be delivered.

The paperwork was substantial to say the least and I imagine that Terry and I have been the subjects of a thorough investigation! The cameras record onto NTSC video cameras with mini DV tapes. Several counts have been completed at the time of writing and the counts suggest approximately 30,000 bats in Bat Cave.

The cameras have been used concurrently from different angles and giving consistent results. They are also directional in that both ingress and egress are recorded and a net result given. It is hoped to continue counts as pups begin to fly and we can hopefully give an insight into the recruitment for the 2009/10 breeding season.

There is still a margin of error with counting the population for a number of reasons:

- Not all bats are in the cave over summer
- Not all bats leave the cave every night
- Each count is limited to 90 minutes, the length of mini DV tape on long play, so late emergences will not be recorded

We now have the capacity to count bats easily and accurately and understand the limitations of the data. More comprehensive surveys of caves over summer to determine if all bats are in Bat Cave will improve the robustness of the data. Further improvements from a total species population census would be improved if the same technique could be implemented at Starlight Cave at Warrnambool, but given its location and accessibility appears unlikely. (Accessing Starlight involves a climbing down a cliff, traversing a rocky shoreline accessible only at low tide and climbing back up the cliff into the cave. The Department for Sustainability and Environment currently has the access route closed for safety reasons.)

Until we can achieve this, the best information we can achieve is to accurately count the Bat Cave population at various times of the year to determine level of usage and recruitment each breeding season.

Bats huddled together in winter torpor.

Naracoorte site interpreter Alison Rowe in Marcollat Cave during the winter survey. This was the most northerly population found, over 70 km north of Bat Cave.

WINTER SURVEYS

A survey of wintering caves was undertaken by Kevin Mott and Fred Aslin in 2000. They and their teams were only able to locate approximately 16,000 bats over their weekend survey and made several recommendations on how further surveys could be conducted (Mott and Aslin 2000).

One was to survey all known sites over single day, to reduce the chances of bats moving from one cave to another overnight, to either be missed completely or counted twice. We also tentatively explored the idea of surveying Victorian caves as well as they suggested, but lack of knowledge on sites and availability of people made this impossible.

Ronald Bonifacio coordinated the survey conducted on 6 June 2009. Members of the Friends of Naracoorte Caves and Cave Exploration Group of South Australia (CEGSA) joined DEH staff with 30 people in six teams involved on the day. Surveyors were briefed prior to the count on minimising disturbance, safety, and provided maps and guidelines on how to estimate cluster sizes to ensure a degree on consistency.

An estimate of 100 bats per square foot (30cm x30cm) was used. Where large clusters are found, each team member was encouraged to independently estimate the cluster size and estimates were averaged.

The survey was also used to gather:

- Photographs of cave entrances.
- Evidence of feral animals. Cats in particular are predators of bats in caves. They leave tell tale evidence as they generally eat the entire bat except the wings.
- Evidence of people using cave such the remains of light sources, new graffiti or damage to the cave.
- Presence of absence of guano and whether this was fresh or old, determined by white fungus that grows on old fungus.

This information was collated by Ronald and became the basis of classifying which caves are priority sites for on-ground protection and restoration activities. A number of caves have been worked on previously including Cave Park Cave, Joanna Bat Cave and Five Corners Cave cleaned by Friends of Naracoorte Caves and Green Corps. Robertson Cave had an artificial entrance closed in an attempt to rstore what was thought to be a maternity site (Baudinette *et al,* 1994) Landholders were approached and were generally very supportive of protection works for caves on their property.

Circumstances on the day of the count assisted this in the case of Monbulla Cave, west of Penola. Surveyors found an injured calf that had fallen into the cave. CEGSA members generously assisted the farmer the following day remove the injured beast from the cave. Monbulla Cave now has a stock proof fence protecting all 30 or so entrances and mesh that covered deep entrances providing limited stock protection but restricted bat access has been removed.

Melangine Cave with a new fence. Note the old mesh lying outside the fence and the soil disturbance from stock.

Two small caves near Kongorong were identified for protection works. Melangine and Koongine Caves (also known as Noonan's Caves) are important Aboriginal art sites. Protective mesh was placed over the cave entrances in the 1980's to protect the art. On the day of the survey the gates to the caves were found open and stock has accessed both causing damage to the cave floors.

The landowner supported installing fencing further back from the cave entrance to provide additional protection. Unfortunately, the fencing contractor removed the mesh making the sites accessible to people again. This has resulted in two letters to the Minister, some serious attention from heritage and Indigenous interests, and considerable discussion on how the art should be protected. Consultation is still ongoing with Indigenous and Heritage representatives to find a solution that achieves both of the sought objectives. The most challenging issue to date is finding agreement on what this solution might be!!

Unfortunately, the 2009 survey was no more successful at locating what we estimate the population is, with only 13,700 bats located. Glencoe West Cave had over 5,000 with five other caves with 1,000 or more. Bats were seen in a further 13 caves of the 40 visited on the day.

A number were not visited as landowners refused access and some others have been blocked in recent years. None of the sea caves could be accessed due to high seas so there is some potential more bats were in the region but not found. More likely is bats had moved across into Victorian caves. Preliminary planning is underway to conduct a survey of all known caves wintering sites for this species in June 2010.

DETERMINING FORAGING HABITAT

Tracking bats to their feeding grounds is difficult; they fly fast, at night and cover vast distances. In 2004, a small project was supported by DEH to gather some information on where Southern Bentwing Bats went to forage. The work formed part of PhD studies of Chris Grant who developed and coordinated the project (Grant, 2004). Limited data was collected which suggested bats tended to follow the vegetation along the Caves Range with one bat tracked on consecutive nights to its feeding grounds over vineyards approximately 15 kilometres from Bat Cave.

I submitted a grant application on behalf of the Friends of Naracoorte Caves which was successful, receiving $16,500 from the World Wide Fund for Nature through the Threatened Species Network. As usual, Terry Reardon from the South Australian Museum has offered huge support and greatly assisted with the implementation of the project, which aims to build on the data gathered in 2004. Ultimately, we hope to identify and conserve habitat required by bats for foraging.

Two sessions of radio tracking were planned; the first was completed in December 2009. Transmitters were attached to five lactating females and one adult male. The next session in February will track some of this season's pups aiming to determine any differences in foraging habitat between adults and juveniles.

We used Holohil LB-2N transmitters, imported from Canada. The transmitters used are necessarily tiny, weighing just 0.43 grams. An adult bat is 15-16 grams so it equates to less that 3% of the bat's body weight. Transmitters were attached by trimming the fur and using glue. Each transmitter has a slightly different frequency signal to enable identification of each bat. They operate for up to 21 days but drop off before that. It is not a cheap exercise as they are $200 each and we are yet to retrieve one after it has been used!

The tracking sounds simple but in reality is not. The plan is that as a bat with a transmitter emerges from Bat Cave, it will be detected by a receiver at the cave entrance. A crew in a plane flying above is notified, who determines which direction the bat has travelled. Once located, the plane crew provide directions to a ground crew and they follow the bat. The plane crew then tries to locate another bat and repeats the process with another ground crew. A number of issues were encountered:

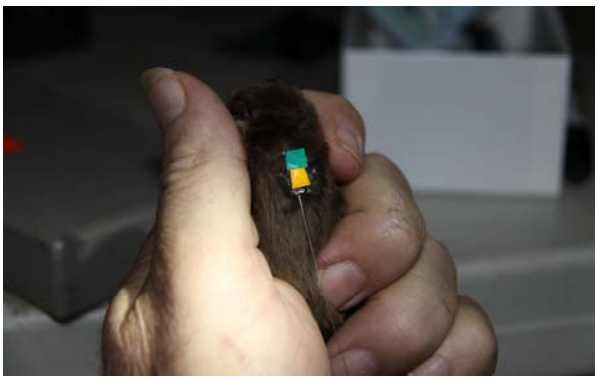
- Bats don't follow roads making the task of following in a vehicle difficult.
- Transmitters have a limited range (although 15km is suggested by the supplier)
- Once a bat is lost by the ground crew the plane has to relocate and provide new directions.

The first two nights of tracking we assigned one ground crew to a bat. The third night we assigned two ground crews to each bat, meaning we could only track two bats from the ground. From tests we conducted prior to tracking, we found we had a range of approximately five to six kilometres from the plane. While bats are close to Bat Cave, they are reasonably easily located. As they venture further the distance the plane has to cover greatly increases and the chance of locating them diminishes.

We used Ozi Explorer software on laptops in the plane to maintain current location of the plane, direct ground crews and record waypoints when we passed over a bat. This collected data on the direction each bat travelled and was coupled with data from ground crews.

The data set is always going to be small when tracking a small number of individuals. The five female bats all travelled south each night and two were tracked consistently to the same area. We managed to track them for over two hours but always lost contact by 11 pm. By this time the bats were over 25 km south of Bat Cave in the Glenroy and Coonawarra area. Bats were located in a variety of habitats including thick vegetation, over cleared land and in a vineyard. The one male we attached a transmitter to travelled north east from the cave on successive nights, opposite to the females. We manage to find it over the border in Victoria east of Mullinger Swamp; over 35 km in a direct route! We tried one last night's tracking after Terry had left with the intention of just following one bat in the plane for as long as we could but had a different receiver and could not detect any bats.

I was a little surprised as to the distance travelled from Bat Cave, especially by lactating females. Is this an indicator that food is short close to the cave? Is there a huge energy requirement to travel this distance that could affect breeding success? This project seems typical of research into this species; the more we do and learn, the more questions we come up with!



The tiny transmitter glued to a bat's back.

The radio tracking work is being undertaken under DEH permit G 2597 with approval from the Wildlife Ethics Committee 55/2009. Population census work is under DEH permit Q25264 and investigations into lesions under DEH permit Y25796.

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