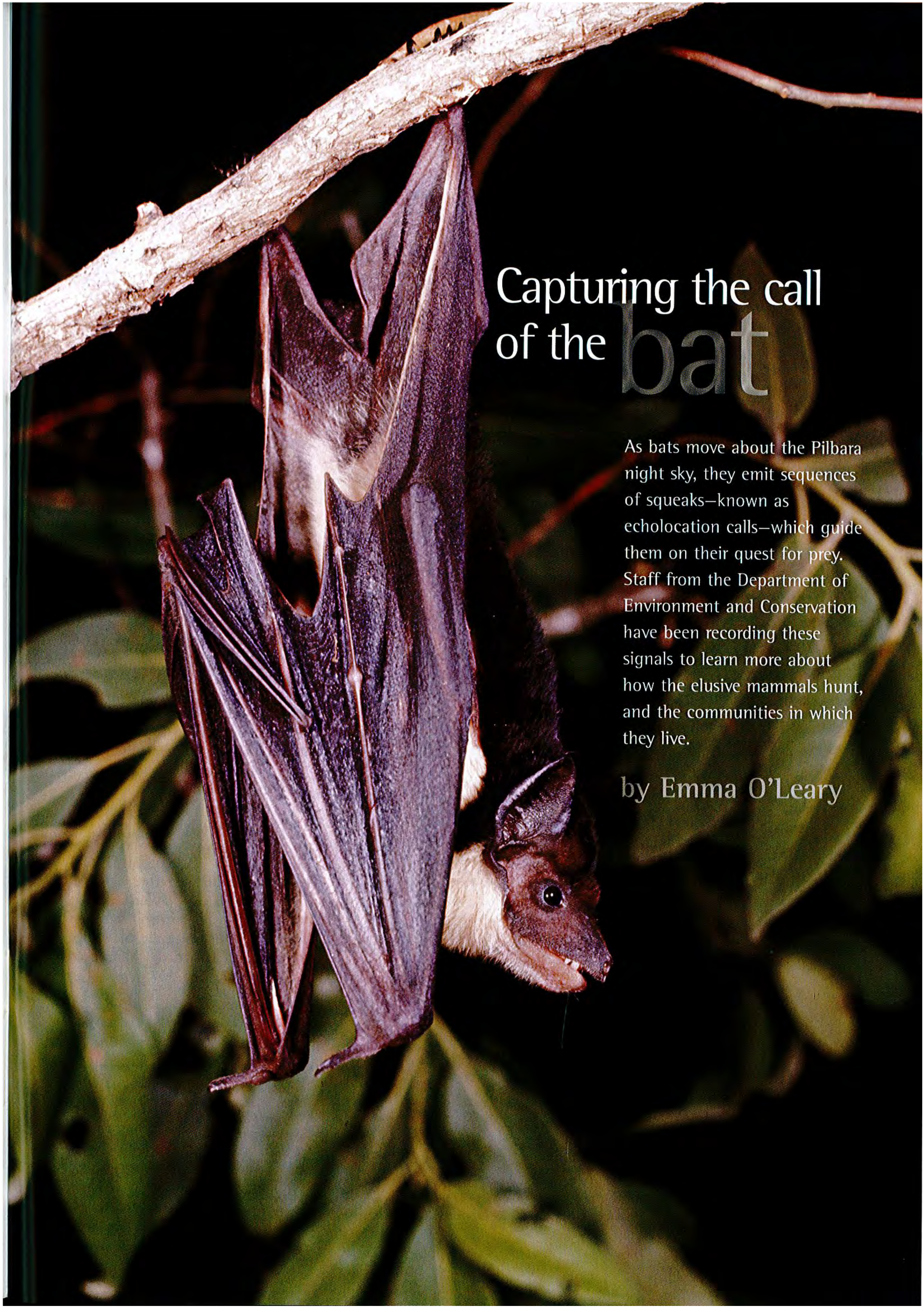


Capturing the call of the bat

As bats move about the Pilbara night sky, they emit sequences of squeaks—known as echolocation calls—which guide them on their quest for prey. Staff from the Department of Environment and Conservation have been recording these signals to learn more about how the elusive mammals hunt, and the communities in which they live.

by Emma O'Leary

On a starry Pilbara night, small digital audio recorders are scattered along creeks and across sand plains, mulga flats, mangroves and low, open woodlands. The recorders are there to trace microbats flying the night sky searching for prey. Microbats are extremely efficient hunters and this is lucky, as the average microbat needs to catch one insect per minute for two or more hours each night to meet its metabolic energy needs. The term 'microbat' is an abbreviation for bats that belong to the suborder Microchiroptera, as opposed to the fruit and nectar-eating bats that belong to Megachiroptera and, unlike the microbats, do not echolocate.

As these small flying mammals emerge from their roosts in the early evening or at night, they generate rapid sequences of high-frequency calls that bounce off objects, and the returning echoes provide details of their surroundings. This echolocation—the same form of communication used by dolphins and toothed whales—is employed by the microbats to navigate and forage.

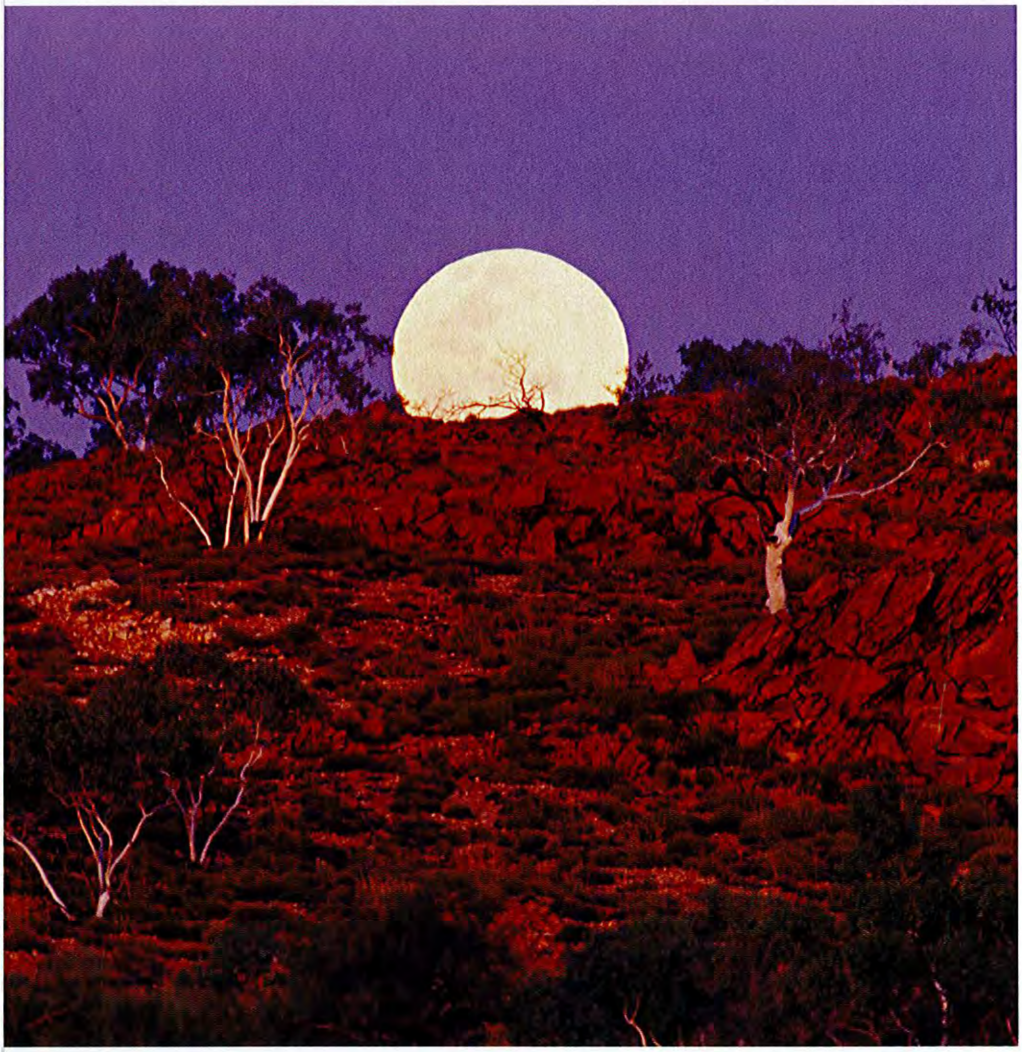
Department of Environment and Conservation (DEC) scientist Norm McKenzie has been studying the echolocation calls of microbats across Western Australia for 18 years. Working together with aeronautical engineer Bob Bullen, he has developed a dictionary of call sequences to help identify the bats in a non-intrusive, fast and more efficient way than traditional methods. Recordings exist of every known bat species in the state, and these are gradually being consolidated into a reference dictionary. The latest digital additions to this extensive library of sounds have come from the Pilbara.

Creating a dictionary

Bats have always been among the most elusive animals to capture in biological surveys. Comprehensive lists of bats and the areas they inhabit are very useful in determining how species live and interact to form communities, but this information takes time to compile. As the dictionary of bat calls progresses, future studies on bat species across WA will be much easier to carry out, because scientists can cross-reference sounds and easily identify species without having to physically trap and handle the bats.

To build the dictionary, bats are captured and dabbed with a non-toxic paint that glows in the dark for a few minutes. The bats are then released and their call sequences recorded using a digital recorder fitted with a high -frequency microphone. Using this method, echolocation calls by free-flying bats of known identity can be documented at sites around the state.

Scientists can learn much about a bat just from its call. The echolocation signal reveals the particular habitat the bat is adapted to hunt in—whether that is on the ground, among the branches of trees and shrubs (where aerial pursuit is the favoured hunting technique) or in the open air above woodland and forest canopies (where aerial interception works best). Increasing the knowledge of just how each bat finds its dinner can



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Main Yellow-bellied sheathtail bat.
Photo – Hans and Judy Beste/Lochman Transparencies

Left On bright moonlit nights, bats are able to use their vision as well as echolocation.
Photo – Jiri Lochman

Above Pygmy long-eared bats hunt along watercourses in the Kimberley and 'top end'.
Photo – Norm McKenzie/DEC

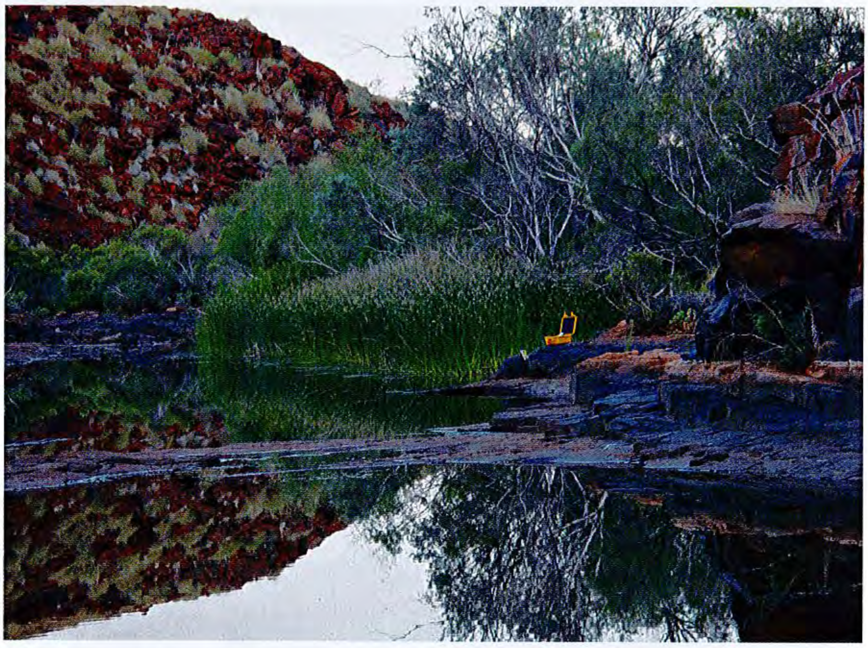
Right Finlayson's cave bat.
Photo – Jiri Lochman

help scientists understand each species' vulnerability against the background of changes happening in many parts of WA, where vegetation structures are being simplified and soil surfaces damaged by overuse of landscapes and high intensity bushfires. The bat sound dictionary provides scientists with clues about the vulnerabilities of different species, revealing their particular habitat requirements and role in ecological communities.

The evolution of bats

Specialisation by bats includes not only the structure and type of echolocation they use, but also extends to the way their airframes are designed and built. Data on body types of different species of bat is also being documented and incorporated into the dictionary. This includes the shape of their wings, the size of their tails—which they use as a rudder—and the size and shape of their ears. A bat's ears aren't just appendages to hear with—they also pre-process the airflow to optimise aerodynamic performance across the rest of the bat's body for a particular style and capability in flight.

Despite their small size, bats are still subject to the same rules that apply to everything that flies. Bats, and even insects, are considered relevant to contemporary aeronautical science, particularly as people try to increase their understanding of flight at different scales. Some microbats, such as the chocolate bat (*Chalinolobus morio*), are able to perform very agile, acrobatic turns that expose them to high wing loads and lateral forces. These turns can create high forces—equivalent to eight or nine times the force of gravity—on circulating blood and the bones that support their structure.



Human pilots can only withstand such forces by wearing special suits which control circulation and stop blood from running into their feet. Chocolate bats can out-turn their insect prey at flight speeds of six metres per second among the clutter of tree branches and foliage, but for this type of activity they must have finely tuned, high-frequency sonar calls. In contrast, the broadly tuned calls of relatively low frequency used by the northern mastiff bat (*Chaerephon jobensis*) are best suited to detect, identify and intercept prey from a distance. This species has wings optimised for fast, straight-line, open-air flight.

Microbats in the Pilbara

The Pilbara bioregion, which covers some 179,000 square kilometres, is known for its rich tapestry of landscapes. It is made up of seasonal river systems, tall riparian forests, low woodlands, grass plains, mangrove forests and a diversity of caves among a complex array of ranges and plateaux.

Top Lesser long-eared bat in flight.
Photo – Noel Speechley

Centre left A Pilbara bat sampling site in a gully on Mount Florence Station.
Photo – Norm McKenzie/DEC

Left Carawine Gorge in the Pilbara.
Photo – Marie Lochman

Above Gould's wattled bat, a very agile species that occurs throughout Western Australia.
Photo - Jiri Lochman

Right Eastern long-eared bat.
Photo - Hans and Judy Beste/Lochman Transparencies

Across these vast landscapes is an extensive range of ecosystems that maintain populations of flora and fauna not known to exist anywhere else on the planet.

The Pilbara bioregion also hosts 17 species of bat that use echolocation to forage and navigate. A bat will emit high-frequency sounds that bounce off objects in front of it, ensuring it doesn't fly into a rock or a tree. Or, if it gets lucky, the bat will register a little 'blip' that it identifies as food—a moth or a beetle perhaps, flying through the night sky, or an ant crawling over leaf litter.

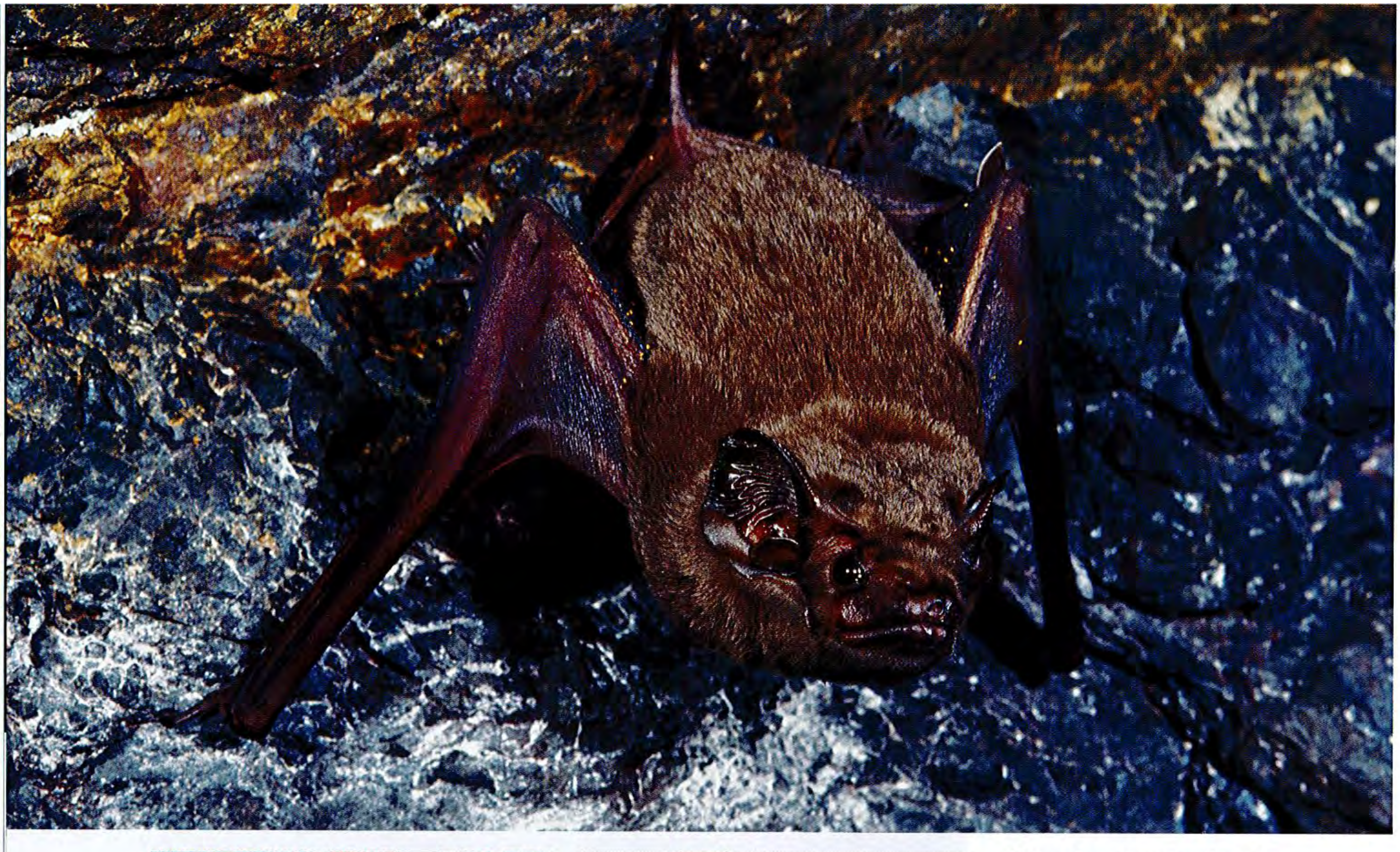
Not all 17 Pilbara bat species catch their food in the same way. There is a well-structured community of bats in the region, and different species hunt in different ways. Because they explore in different places—around bushes, along the ground or in the open sky—they use different echolocation frequencies. Their call is specific to the situation they hunt in and, through the evolution of bat communities, different family groups have become specialised to carry out different sorts of hunting.

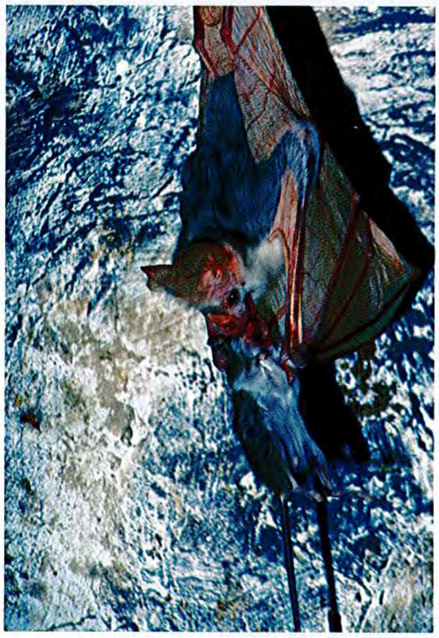
Small night-time animals such as insects live in a whole array of places in the bush—on the ground, on the bark or leaves of trees, flying around flowers, or out in the open air—and there is a bat in each community designed to hunt for that sort of animal in those particular places. The bat's echolocation signal gives it an auditory image—an image of what's out in front of it, including its prey—in its brain. It overlays any visual image it can glean in the dark, which may not be much at all in some situations. Humans are not capable of deriving this type of auditory image from their ears, but bats can.

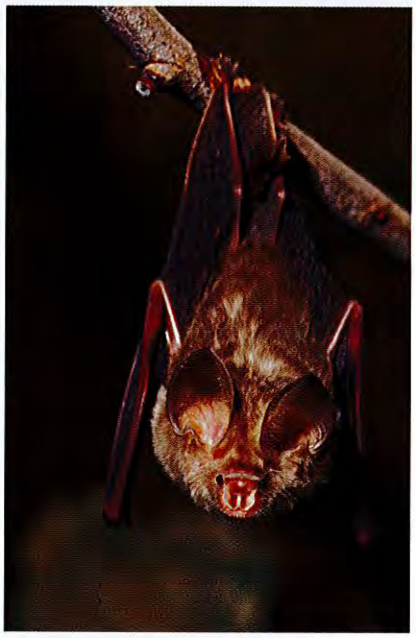
Bat data shows diversity

A DEC survey was carried out to gather data on bat echolocation, flight behaviour and foraging ecology in the Pilbara. The comprehensive survey encompassed 69 sites dispersed among 24 survey areas covering the entire region. While many bats were trapped for observation, the main focus was recording echolocation. These recordings were processed using software which matched bat echolocation sounds to the existing call dictionary, and identified the species that had flown past.

The Pilbara is the most recent region to be surveyed in what has become a statewide bat project. Bat recording data exists in varying formats for every known species of microbat in WA, though not all of it has been consolidated into the dictionary. Additionally, further recordings in a consistent, standard format are required for more accurate comparisons between some species, and to clarify region-to-region variation in calls by the same bat species.







Above Common sheathtail bat.

Far left Ghost bat.

Left The dusky leaf-nosed bat is a Kimberley species.
Photos – Jiri Lochman

The echolocation survey not only recorded all 17 Pilbara microbat species, it also revealed two distinct communities. One comprised 14 species that occupied landward environments, while the other community had nine species and lived in mangroves. (A few species were present in both communities.) The highest diversity of bats was recorded in productive riparian areas with complex vegetation structures and permanent pools set in cavernous landscapes.

The bat species forming each community showed clear differences from each other in terms of foraging behaviour and flight capabilities. Some bats hunted in the open air, clear of obstructions, while others hunted in cluttered air spaces close to surfaces. Many species hunted in various intermediate levels of clutter. There was significant variation in the way different species maneuvered. Some species were able to turn at low speeds, or even hover, while others specialised in tight, agile turns at moderate speeds and some demonstrated only limited agility but were able to fly at high speed. In one instance, six long-eared bats captured, tagged with non-toxic glowing paint and released were observed foraging among the upper branches and canopies of river gum woodland, up to 20 metres above the ground. They would perch for several minutes at a time, then spiral slowly through the canopy before flying to the next canopy—behaviour consistent with ambushing and gleaning. Species observed to intercept their prey in open airspace well clear of vegetation used straight, high-speed flight and had relatively low agility, while bats that foraged close to surfaces in cluttered environments showed either moderate to low agility in conjunction with low flight speeds or high agility in conjunction with moderate flight speeds.

Conservation

The Pilbara bat project was part of a wider biological survey carried out by DEC. The main objective of this wider survey was to determine the sorts of plants and animals that live in the region's different environments. The information is being used to monitor the condition of WA's wildlife, to assist

Above Nightfall in the Pilbara. Most bats emerge later, when it is completely dark. *Photo – Marie Lochman*

Right Northern long-eared bat. *Photo – Stanley Breeden/Lochman Transparencies*

in selecting future conservation reserves and to assess the comprehensiveness, adequacy and representativeness of the state's conservation reserve system. Information from the survey will also inform management decisions for the region to ensure the protection of environments that support a wide range of animals and plants.

Results from the survey revealed significant information on the distribution and conservation status of the Pilbara's bat species. In some instances, species that were thought to be extremely rare were found to be more widespread. Others were confirmed to exist in only one location or in one type of habitat, or to visit the region seasonally.

The survey identified several factors relevant to planning for conservation. It showed that loss of complexity in riparian vegetation, reduced permanence of pools, loss of mangrove stands and loss of suitable cave roosts were likely to reduce or even destroy bat populations in the Pilbara. Several areas were flagged for conservation, including Weeli Wolli Spring, which supported the richest assemblage of bats located during the survey.

The survey confirmed that Pilbara microbats have not yet suffered the extinctions experienced among other fauna in the region, but concluded that a comprehensive reserve system would be required to preserve these intact and fascinating microbat communities. The bat echolocation dictionary will be useful as a quick, inexpensive and non-invasive way to identify bats during environmental surveys of potential mine sites and for monitoring.

What's next?

Like the Pilbara, the highly rich and diverse Kimberley is home to many species of bat that hunt using echolocation. Twenty-two species of microbat are known to live here and DEC is now compiling an echolocating dictionary for this region, as part of a field survey of islands along the north Kimberley coastline that includes bat surveys. Once again, the surveys aim to increase understanding of how bat species congregate and hunt, and the studies in the Kimberley are revealing a complex model. There is a lot more that can be learnt about bats from studying these 22 Kimberley bat species.

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