Orange leaf-nosed bat *Rhinonicteris aurantia*

Vulnerable (*Nature Conservation Act 1992*) | Ecological Sciences, Queensland Herbarium

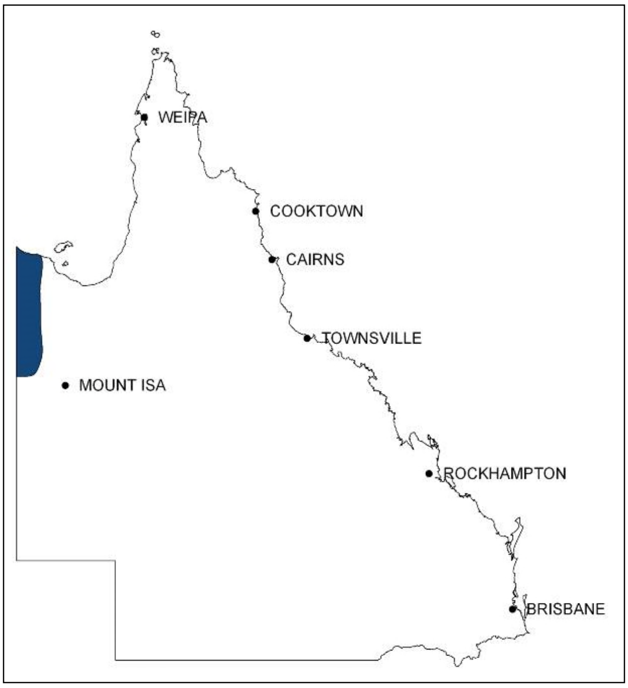
Identification

Rhinonicteris aurantia is distinctive and readily identifiable. The nose-leaf is elaborate, diamond-shaped, with the upper part scalloped. Ears are small and acutely pointed. Fur is usually bright orange with dark brown wing membranes. However, the fur of individuals or entire colonies can also be light brown, pale yellow or white. *Rhinonicteris aurantia* is a small bat; weight 6.5-11.2 g, forearm length 45-50 mm (Churchill 2008; Churchill et al. 2008).

Echolocation call

The echolocation pulses are readily identifiable. Calls are characterised by a constant frequency (CF) component 5-8 milliseconds in duration at a characteristic frequency of 109-117 kHz (up to 10 kHz higher in the Pilbara region of Western Australia), terminating in a steep downward FM sweep spanning c. 20 kHz. A brief upward FM sweep at the beginning of the pulse is not always detectable (Armstrong and Coles 2007). The detection range of *R. aurantia* calls is approximately 2 m (Milne 2002; Lumsden et al. 2005), but is dependent on atmospheric conditions and recording equipment.

Compared to the calls of the sympatric species northern leaf-nosed bat *Hipposideros stenotis*, pulses of *R. aurantia* are shorter in duration (5-8 ms compared with 10-20 ms for *H. stenotis*) (McKenzie et al. 1995; Milne 2002) and higher in frequency (Armstrong and Coles 2007).



Distribution

Rhinonicteris aurantia is endemic to Australia. In Queensland *R. aurantia* occurs in the north-west of the state, close to the Queensland/Northern Territory border. The distribution continues through the Top End of the Northern Territory to the Kimberley region of Western Australia (Churchill et al. 1988). A relictual population in the Pilbara is currently considered a separate form and is listed as Vulnerable under the EPBC Act 1999 (DSEWPC 2012).

Habitat: roosting and foraging

This species requires cave roosts with specific microclimate conditions during the dry season, caves must be hot (28-32°C) with high relative humidity (85-100%) (Churchill et al. 1987; Jolly 1988). In the Northern Territory large numbers of *R. aurantia* disperse from these roosts during the wet season, when conditions are more humid, temperatures fluctuate less, food is more abundant, and females experience increased energetic demands from lactation (Churchill 1991; Churchill 1995). It has been proposed that *R. aurantia* roost in tree hollows during this time, based on Gould's (1851) observation that they roost in eucalypt hollows. However, no observations of tree roosting have been made since.

Two colonies of *R. aurantia* are known in Queensland: Kalkadoon Cave near Camooweal (with a preponderance of the white colour morph) and Lawn Hill Gorge National Park. Both colonies are small with <100 individuals (Churchill et al. 1987; Churchill 1991).

Rhinonicteris aurantia forages in a wide variety of habitats across its range, including monsoon rainforest, tall open forest, mangroves, palm forest, open savannah woodland, black soil grassland and spinifex grassland (Churchill et al. 1987; Churchill 2008). The two colonies known from Queensland occur amongst grasslands with scattered stands of eucalypt woodland (Kalkadoon Cave), and open eucalypt forest with cabbage tree palms lining creeks (Lawn Hill Gorge) (Churchill et al. 1987). This species is known to forage over open grasslands and sparse tree and shrub savannah in WA (McKenzie et al. 1999). *Rhinonicteris aurantia* may be more limited by the availability of caves with suitable microclimates for dry season roosts than by habitat type (Churchill 1991; Armstrong 2001).

When foraging or emerging from the roost *R. aurantia* flies low, < 3 m above ground, in a zig-zag pattern (Churchill et al. 1987). Commonly forages in gorges, gullies, over water, and close to the roost. Some individuals may remain near the entrance of the roost and continually enter and re-emerge for several hours after an initial emergence at dusk (Armstrong 2001; DSEWPC 2012). Nightly foraging distance has not been determined, but might be significant, up to several kilometres.

Seasonal and timing considerations

Rhinonicteris aurantia vary seasonally in the use of roosts in the Northern Territory, with colonies leaving cave roosts during the wet season (November to February) (Churchill 1991; Churchill 1995). It is unknown whether the colonies in Queensland do the same. In the arid Pilbara region, bats appear to contract back to the deepest roosts that can maintain suitable roost microclimates in the hot, dry periods (Armstrong 2001). The species has the potential to be present in all seasons, and both permanent and seasonally available roosts are important resources for basic survival given their physiological fragility (Kulzer et al. 1970; Baudinette et al. 2000).

Recommended survey approach

An approach comprised of acoustic detection, searches for potential cave roosts and confirmation of daytime roosting will provide essential information for assessing the likelihood of a proposed impact on the species from a proposed activity or development. The approach will need to include methods that are non-invasive, given 1) their sensitivity to disturbance in their roosts; and 2) their physiological fragility. Based on the precautionary principle, it should be assumed that disturbance to roosts will cause the species to vacate, possibly resulting in increased mortality if bats relocate to caves with suboptimal microclimates. We recommend a survey approach similar to that outlined for the Pilbara form of *R. aurantia* in the Australian Government's 'Survey Guidelines for Australia's Threatened Bats' (DEWHA 2010).

Acoustic detection: passive monitoring

Electronic devices (bat detectors) should be placed to record over a full night in a variety of habitats, but particularly near pools, in gorges and gullies, rocky outcrops and at potential roost entrances to detect the presence of *R. aurantia*. The number of bat detector nights should be maximised to increase detection potential. Their echolocation calls are readily identifiable from the characteristic (or more accurately the maximum or peak) frequency, pulse shape and power spectrum envelope, enabling even short call sequences with few pulses to be successfully recognised. However, such high frequency calls have a limited detection range, which is further exacerbated by humid atmospheric conditions (Milne 2002; Lumsden et al. 2005; Armstrong and Kerry 2011). If using an Anabat detector, the sensitivity must be set relatively high (c. 9), but recognising the trade-off that the calls of other species will be of lower quality. Spurious noise from insects can simply be ignored during inspection in AnalookW software. Anabat analysis should include Anabat ZCA files, which can be produced during data download and interpretation in addition to the normal parsing process that produces sequence files in folders according to survey night. The use of filters should not be relied upon because they will often exclude fragmented calls (often still identifiable in Anabat format) or even parts of whole calls that can be useful for identification.

Other types of bat detector with a different microphone frequency response, or more importantly a differently shaped zone of reception could increase the likelihood of detection. Important considerations for using full spectrum bat detectors will be gain and trigger level settings, which should be maximised for sensitivity. It is important to note that conversion of WAV format full spectrum recordings to Anabat ZCA format (using one of several available options) has the potential to exclude fainter or lower quality calls, and analyses should take this into consideration. Depending on the survey objectives, it may or may not be critical to recognise every single pulse in a nightly recording. Thus, ZCA-converted recordings may need to be re-analysed in the original WAV format to confirm absence of the species in a recording.

Acoustic detection: active monitoring

In addition to the placement of bat detectors at 'passive' or 'stationary' overnight recording sites, the species can sometimes be detected readily in an area by 'active monitoring'. This involves walking in potential habitats such as mine and cave entrances, gullies, gorges and near rocky outcrops and pools for at least 2 hours after sunset with a hand held bat detector. *Rhinonicteris aurantia* reportedly has a curiosity for small light sources such as headtorches, which effectively brings them within range of hand held detectors (DEWHA 2010).

Echolocation calls can be identified aurally by an experienced observer or from a screen display of a bat detector with that capability. Spotlighting detected bats can also be useful, since the bright orange fur is distinctive, but pale morphs may be indistinguishable from other similar-sized species of bat. *Rhinonicteris aurantia* has moderately fast, agile flight compared to other cave roosting bats such as *Vespadelus* spp., but this takes experience to recognise. During the transect, a continuous recording of echolocation should be made for later analysis and verification purposes. In addition, GPS tracks of transects should be kept to quantify effort and highlight areas surveyed (DEWHA 2010).

Searches for potential roost habitat

Prior to the survey it is important to establish whether there are any caves and mines in the area of interest, and any known roosts. Further searches for additional caves in gorges, gullies, fissures, rocky outcrops, and cliff lines should also be conducted at the site for potential roosts of this species. Several hours per day may be required to conduct ground-based surveys for caves and mines.

The most prospective caves can then be monitored for the emergence of bats at dusk. If the search area is large, it can be useful to reduce it to only those areas most likely to contain caves, on the basis of geology and landforms, and with the use of mapping software, geological and land system maps and aerial photographs. It can sometimes also be economical for a helicopter reconnaissance to narrow the search to the outcrop areas most likely to contain caves, and to save GPS points of sites of particular interest during the flight. It should be noted that cave depth cannot be determined reliably from the cave entrance, so roosting likelihood is difficult to assess solely on the basis of an examination of the entrance. Given that cave entry might disturb a colony, or be restricted for safety reasons by a client, there are two options for assessing caves. The first involves the placement of bat detectors at the cave entrance to record overnight, and is the least invasive option but does not confirm roost occupancy. The second involves separating bats that fly into caves from those that fly out after sunset (see below).

Confirming daytime roost occupancy

Acoustic detection of *R. aurantia* at cave or mine entrances after sunset is not a confirmation that the structure is used during the day as a roost, since this species will often fly into caves whilst out foraging at night. Some caves might be used as 'night roosts', which provide a temporary refuge when individuals are foraging far from a daytime roost. Given this behaviour, and their sensitivity to disturbance, daytime occupancy needs to be determined using a method that takes this behaviour into consideration and can also provide an unambiguous result.

One such method is detailed by the Commonwealth (DEWHA 2010; DSEWPC 2012), and involves covering the cave entrance with a large piece of cloth prior to sunset. A bat detector is placed on each side of the cloth, and monitored for up to 2 hours after sunset. Care needs to be taken that bats on the outside of the entrance are not confused with those attempting to fly out. The outside can be monitored with any type of detector, including heterodyne detectors, but preferably those with a recording function for later verification. The detector on the inside should be placed or shielded so that it will not detect calls from the outside. Directional models such as Anabat are ideal, and all calls from inside the cave should be recorded for later verification. The cloth is removed as soon as presence of the species is confirmed, or after the two hours for passive recordings (*R. aurantia* will typically leave a roost upon full darkness). If calls of *R. aurantia* are detected within the cave in the two hour exclusion period, the cave can be considered as a daytime roost. Whilst employing this method, care must be taken to ensure that other bat species are not significantly impacted, especially the ghost bat *Macroderma gigas*, and all activity at the entrance should be conducted with minimal noise. Other methods of occupancy determination would be acceptable if they were less invasive than that described, and which could provide an unambiguous result.

Capture techniques

This species should not be trapped at cave or mine entrances simply for the purpose of identification or determination of presence/absence. Capture is also not an appropriate method for determining unambiguously whether a cave is used as a daytime roost. If, however, capture at cave or mine is required for another legitimate reason, then harp traps are the best apparatus to employ. *Rhinonicteris aurantia* can easily detect and avoid mist nets set in the open (DEWHA 2010), but there have been several instances of capture in watercourses using harp traps in the Pilbara, and under single trees in open woodland (Lumsden et al. 2005). The effectiveness of harp traps can be increased through the placement of mist nets or light cloth sheets on either side that might help to funnel bats into the trap. Captured individuals must be released as soon as possible during the night. Harp traps at cave entrances should be monitored constantly, and when placed away from caves in areas most likely to capture this species, the harp should be checked before dawn so that bats do not need to be held for release until the following evening.

Survey effort guide

Echolocation calls of *R. aurantia* are recorded less commonly than other species, which is a function of their detectability due to call frequency and atmospheric conditions, and local abundance. For example, only 13 call sequences were recorded in 660 detector hours over 51 nights across 39 sites in a bat fauna survey of the Top End of the NT (Milne et al. 2004), but 55 call sequences were recorded over 75 nights across 75 sites in a bat fauna survey of the Ord River in WA (Lumsden et al. 2005). In the same study, a trap success of 2 bats/61 harp trap nights was reported for this species (Lumsden et al. 2005). Note that neither of these surveys were specifically designed to target *R. aurantia* and these are the capture rates recorded for the species during multi-species bat surveys.

In the case of *R. aurantia*, most effort should be placed into acoustic detection and the confirmation of roosts in caves and mines. While detectability is relatively low compared to some species, their call is not easily misidentified, and they will be more readily recorded than captured in the open if sufficient passive and active recordings with bat detectors are made. Thus, significant expenditure of trapping effort for this species is not required, and avoids situations that place individuals at risk of mortality, such as trapping at cave entrances, leaving bats for extended periods in harp bags and holding until release on the evening following capture.

Per 100 ha of project area		
Survey technique	**Minimum Effort**	**Minimum number of nights**
Passive monitoring	20 detector nights	4 nights
Active monitoring	8 detector hours	4 nights
Harp trapping (optional)	8 trap nights	4 nights
Roost searches	Minimum 2 hours per survey day, but dependent on local landscape	
Assessment of roost occupancy	Maximum 2 hours per roost	

Ethical and handling considerations

Rhinonicteris aurantia is physiologically fragile, this species cannot enter torpor and their rates of evaporative water loss are extremely high (Kulzer et al. 1970; Baudinette et al. 2000). Exposure to extended cold (< 20°C) leads to hypothermia, dehydration, exhaustion, and often death (Kulzer et al. 1970). As a result individuals can die in traps or bags if they are held for too long (Churchill 2008). It is highly desirable that bats are rereleased at night and not held until the following evening. Extended handling and manipulation for photographs is discouraged.

Roost searches

- *Rhinonicteris aurantia* are highly sensitive to disturbances at the roost.
- Do not enter roosts occupied by *R. aurantia* during the day (night might be acceptable, given the situation, and judgement should be exercised). Entering their roosts during the day can be disastrous, causing a mass exodus and/or abandonment of the roost for several weeks or months following the disturbance (DEWHA 2010).

- Roosts entrances should not be trapped or netted to capture *R. aurantia*. The capture of individuals at roost entrances can cause the bats to vacate to less suitable roosts nearby, increasing the risk of mortality.
- Every effort should be made to minimise disturbance at the roost. Be as quiet as possible when working at the entrance of roosts.
- The number of people entering and searching a cave or mine for bats should be kept to a minimum.
- Any damage to the bat roost, such as removing rubble blocking corridors is unacceptable, even if these activities would increase the effectiveness of the search.

Capture

- Allow sufficient time to ensure the final check and closure of all traps occurs before early dawn.
- Harp traps must be checked at least twice during the night, and monitored constantly at cave/mine entrances.
- Place bats into a dry calico bag, avoid over-crowding, and keep bags off the ground. Process and release bats as soon as possible, ideally within 2 hours of capture.
- Release bats close to their point of capture while it is dark.
- Care should be taken when working around or handling microbats due to zoonotic diseases, such as Australian bat lyssavirus (for further information see www.health.qld.gov.au). Only fully vaccinated personnel are to handle bats.

Acknowledgements

These guidelines were prepared by Clare Hourigan in October 2011. Advice and comments on drafts for *Rhinonicteris aurantia* were provided by Kyle Armstrong.

Citation

Hourigan, C. 2011. Orange leaf-nosed bat, *Rhinonicteris aurantia*. Targeted species survey guidelines. Queensland Herbarium, Department of Environment and Science, Brisbane.

Key references

Armstrong, K.N. (2001). The roost habitat and distribution of the orange leaf-nosed bat, *Rhinonicteris aurantius*, in the Pilbara region of Western Australia. *Wildlife Research* 28: 95–104.

Armstrong, K. N. (2008). Pilbara leaf-nosed bat *Rhinonicteris* aurantia. In: 'The Mammals of Australia.' (Eds S. Van Dyck and R. Strahan) pp. 470-471. Reed New Holland: Sydney.

Armstrong, K. N. and Coles, R. B. (2007). Echolocation call frequency differences between geographic isolates of *Rhinonicteris aurantia* (Chiroptera: Hipposideridae): implications of nasal chamber size. *Journal of Mammalogy* 88(1), 94-104.

Armstrong, K. N. and Kerry, L. (2011). Modelling the prey detection performance of *Rhinonicteris aurantia* (Chiroptera: Hipposideridae) in different atmospheric conditions discounts the notional role of relative humidity in adaptive evolution. *Journal of Theoretical Biology* 278: 44–54.

Baudinette, R.V., Churchill, S.K., Christian, K.A., Nelson, J.E., and Hudson, P.J. (2000). Energy, water balance and the roost microenvironment in three Australian cave-dwelling bats (Microchiroptera). *Journal of Comparative Physiology B* 170: 439–446.

Churchill, S. K. (1991). Distribution, abundance and roost selection of the orange horseshoe bat *Rhinonycteris aurantius*, a Tropical Cave-dweller. *Wildlife Research* 18, 343-353.

Churchill, S. K. (1995). Reproductive ecology of the orange horseshoe bat *Rhinonycteris aurantius* (Hipposideridae: Chiroptera), a Tropical Cave-dweller. *Wildlife Research* 22, 687-698.

Churchill, S. K. (2008). 'Australian Bats'. Allen and Unwin: Sydney.

Churchill, S. K., Helman, P. M. and Hall, L. S. (1987). Distribution, populations and status of the Orange Horseshoe Bat, *Rhinonicteris aurantius* (Chiroptera: Hipposideridae). *Australian Mammalogy* 11, 27-33.

Churchill, S. K., Jolly, S., Hand, S. and Milne, D. J. (2008). Orange leaf-nosed bat *Rhinonicteris aurantia*. In: The Mammals of Australia. (Eds S. Van Dyck and R. Strahan) pp. 468-469. Reed New Holland: Sydney.

DEWHA (2010). 'Survey Guidelines for Australia's Threatened Bats'. Department of the Environment, Water Heritage and the Arts, Commonwealth Government: Canberra.

DSEWPC (2012). *Rhinonicteris aurantia* (Pilbara form) In: Species Profile and Threats Database. (Department of Sustainability, Environment, Water, Population, Communities: Canberra). Available from: http://www.environment.gov.au/sprat. Accessed 20 April 2011.

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

Jolly, S. (1988). Five colonies of the orange horseshoe bat, *Rhinonycteris aurantius* (Chiroptera: Hipposideridae), in the Northern Territory. *Australian Wildlife Research* 15, 41-19.

Kulzer, E., Nelson, J. E., McKean, J. L., and Mohres, F. P. (1970). Temperature regulation in Australian bats (Microchiroptera). *Zeitschrift fur vergleichende Physiologie* 69, 426-451.

Lumsden, L., Churchill, S. and Schulz, M. (2005). 'Bat survey of the Ord River Stage 2 M2 Area, Western Australia'. Arthur Rylah Institute for Environmental Research, Department of Sustainability and Environment: Victoria.

McKenzie, N.L., Fontanini, L., Lindus, N.V., and Williams, M.R. (1995). Biological inventory of Koolan Island, Western Australia 2. Zoological notes. *Records of the Western Australian Museum* 17: 249–266.

Milne, D. J. (2002). 'Key to the bat call of the Top End of the Northern Territory. Technical Report No. 71'. Parks and Wildlife Commission of the Northern Territory: Darwin.

Milne, D. J., Armstrong, M., Fisher, A., Flores, T. and Pavey, C. R. (2004). A comparison of three survey methods for collecting bat echolocation calls and species-accumulation rates from nightly Anabat recordings. *Wildlife Research* 31, 57-63.