INITIAL VETERINARY CARE
FOR NEW ZEALAND BATS

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INITIAL VETERINARY CARE
FOR NEW ZEALAND BATS

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1. INTRODUCTION

These guidelines for the care of bats have been developed for situations when a bat may be injured, or found on the ground. It provides guidance for only the first few days of care. If bats are to be kept for longer periods then specialist veterinary care will be required. This document provides a bibliography and links to information that may be useful for longer term care.

It is important to note that New Zealand bats cannot be kept for any length of time without permission from the Department of Conservation[1]. If bats are found or passed on to carers or veterinarians then it is the responsibility of the carer/ veterinarian to contact the Department as soon as possible, to report any sick, injured, or dead indigenous wildlife, using their emergency hotline 0800 DOC HOT (0800 362 468). This should include any bat that is found on the ground during the day. Information is provided in this report for situations where a bat may need to be rescued.

If you find a bat on the ground or out during the day, then it is likely that it is injured and needs care from a veterinarian. Please refer to Appendix 6 for detailed advice on how to collect and transport a bat to a veterinarian.

Any bat that has been come across randomly (i.e. is unlikely to be injured) and appears sick, lethargic, or particularly aggressive should be handled only with extreme care, and always with gloves that will withstand a bite. This is because the bat may have an undiagnosed disease, or have been poisoned, and the handler must protect themselves as a priority.

[1] The Department of Conservation best practice manual of conservation techniques for bats v1.0 (Sedgeley *et al.* 2012) states: "*The full legal implications for handling and temporary holding native bats have not been tested. A permit may not be strictly necessary to help a sick or injured bat, and we do not wish to discourage people from helping them. However, bats should be handed in to either a vet or wildlife care group or DOC as soon as possible. Vets should be encouraged to report any bats coming into their care to DOC. We do not recommend that untrained people keep sick, injured or abandoned bats. These bats should be tended by those that are expert in such matters*" (Page 85).

2. BACKGROUND INFORMATION

2.1 New Zealand bats

The behaviour and physiology of New Zealand bats are quite different from other mammals that are normally cared for by veterinarians.

New Zealand bat species are nocturnal, and use a combination of echolocation, listening, and vision to navigate when they are active at night. They use torpor as a method of saving energy during the day and when conditions are not favourable at night, but do not appear to use long periods of hibernation (Czenze *et al.* 2016; See Section 2.4.1 for a summary of torpor and how this may affect treatment)[1].

It is thought that New Zealand bats mate in autumn and female use a form of delayed ovulation or implantation to delay when they are heavily pregnant until late Spring/early Summer (Dekrout 2009; See Section 2.4.2 for a brief summary of the bat breeding cycle).

These features of bat biology need to be taken into account when considering the treatment of bats.

There are two extant bat species known to be present on the New Zealand mainland. A third species - the greater short-tailed bat (*Mystacina robusta*) - is likely to be extinct and was last observed on islands southwest of Rakiura/Stewart Island in 1965 or 1967 but is thought to have been extirpated by rats (Daniel and Williams 1984, Lloyd 2005, O'Donnell *et al.* 2018).

[1] The longest period of torpor recorded was 120.8 h (Czenze *et al.* 2016).

Long-tailed bat (*Chalinolobus tuberculatus*)

- Under threat of extinction; ranked as Threatened-Nationally Critical in 2017 because the taxon is thought to be undergoing a high rate of decline, i.e. >70% over three generations or 10 years, whichever is longer; O'Donnell *et al.* (2018).
- 8-10 grams (O'Donnell 2005), which is smaller than a mouse (*Mus musculus*).
- Usually associated with forests but is widely distributed. Found, at least occasionally, in urban areas including Waitākere, Hamilton, and Rotorua.

Plate 1: Adult long-tailed bat, *Chalinolobus tuberculatus*.
Photograph: K. Borkin

Lesser short-tailed bat (*Mystacina tuberculata;* known as the short-tailed bat)

- Three sub-species: northern, central, southern.
- Risk of extinction varies regionally. In 2017, the northern sub-species was ranked as Threatened-Nationally Vulnerable, the central sub-species is At Risk-Declining, and the southern sub-species is At Risk-Recovering (O'Donnell *et al*. 2018).
- All populations are reliant on predator management for ongoing survival.
- The distribution of short-tailed bat is thought to be more restricted than long-tailed bat, which appear to occur widely across New Zealand.
- 10-14 grams (Lloyd 2005), which is slightly smaller than a mouse.
- Roost in cavities, splits, and under peeling (exfoliating) tree bark, large hollow tree stumps, within hollow tree ferns, and in caves.
- Short-tailed bats are unusual as they can fold up their wings and use them like legs, to scramble around the forest floor and through the canopy.

Plate 2: Adult lesser short-tailed bat, *Mystacina tuberculata*.
Photograph: J. Scrimgeour.

2.2 Bat diseases, illnesses, and parasites

New Zealand bats are not known to have rabies or Australian Bat Lyssavirus, both of which can be transmitted to humans by bodily fluids, but little testing has taken place (K. McInnes, Department of Conservation, pers. comm., 27 March 2019). Australian species closely related to the long-tailed bat, i.e. in the same genus, have been recently confirmed with Australian Bat Lyssavirus (Field 2004; including *Chalinolobus morio*, Prada *et al.* 2019).

The suite of viruses that long-tailed bats may carry or contract has not been investigated (K McInnes, Department of Conservation, pers. comm., 27 March 2019).

Short-tailed bats are known to carry a number of viruses and zoonoses, despite only limited investigations: coronaviruses, papillomavirus, polyomavirus, calicivirus, and hepevirus were found in a limited number of samples of short-tailed bat guano from Whenua Hou/Codfish Island (Hall *et al.* 2014; Wang *et al.* 2015). A small, opportunistic, study of short-tailed bat carcasses from Whenua Hou/Codfish Island by Duignan *et al.* (2003) confirmed one case of hepatitis and numerous bats with Sarcocystis infections. A translocation was undertaken of juvenile short-tailed bats from the Tararua Range to Kāpiti Island (via captivity at Mt Bruce). Severe lesions on their pinnae were detected nine months after release on Kāpiti Island, resulting in damage severe enough that all were taken permanently into captivity (Lynn Adams, Department of Conservation, pers. comm., 29 April 2019).

New Zealand bat species have their own ectoparasite communities and a low level of occupation is considered to be normal. For the short-tailed bat these include a pseudoscorpion (Finlayson *et al.* 2015), several undescribed species of mites, as well as mesostigmatid mites (Lloyd 2005), A sarcoptic mange mite was suspected to cause high levels of mortality in young captive-born bats as a result of massive subcutaneous secondary infection (Lloyd 2005), although low levels of mite infestation is normal and the relationship between mites and disease in bats is relatively unstudied. If parasites are firmly embedded in the bat then it is preferable to leave them where they are, to reduce the risk of leaving the head and jaws embedded in the bat, possibly resulting in infection (Sedgeley *et al.* 2012).

Mite infestation may have led to the deaths of six bats in captivity in Wellington Zoo in 1981 (Heath *et al.* 1987). Heath et al. (1987, p.42) described the incident as follows:

> *"In June, [however,] the bats intake of honey water fell noticeably, but not their intake of mealworms, and by early August three bats were observed with scabby lesions on their ears. On 27 August, one male bat was found dead in the enclosure. The animal was apparently in good condition with no obvious external defects or damage, except for lacerated ears, which were encrusted with a dried exudate of serum and blood […]. The pinnae of the remaining five live bats were affected by a "weepy" exudate. Another bat died in September 1981: once again there were no obvious internal or external lesions, apart from badly lacerated pinnae encrusted with exudate."*

A tree stump provided as a roost was examined and noted to have numerous arthropods crawling over it. The roost was cleaned, sacking removed[1], and treated twice with a pyrethrum-based aerosol. Four days later, the bats were treated with pyrethrum dust (0.05% active ingredient, Heath *et al.* 1987[2]). Heath *et al.* (1987 p.44) describes further:

> *"Four days after treating the bat roost, it was noted that the lesions on the ears of the remaining four bats showed signs of healing. Furthermore, close examination of the bats during dusting showed that the "weeping" of the ear lesions had stopped; the exudate was dry and not fresh. Over the next six weeks, however, all remaining bats died and were necropsied. On examination, it was noted that all four had a severe exudative dermatitis affecting the distal half of the pinnae […]. Histology of the ears showed large scabs of necrotic debris; inflammatory cells and colonies of bacteria and fungi covered all the affected pinnae. The distal half of the involved area was gangrenous. In three bats, leucocytes had accumulated on the walls of blood vessels of the lungs, which indicates an early inflammatory stage. One bat had several small bacterial colonies in its liver, with one showing an associated inflammatory reaction. This is consistent with terminal septicaemia. The same bat also had two similar colonies in the glomeruli of the kidney. No other pathological features were found that could establish the cause of death."*

The deaths were thought unlikely to be related to the treatment with pyrethrum due to its reported low toxicity with mammals (Heath *et al.* 1987). Heath *et al.* (1987) suggested that the ear infections were severe enough to produce toxaemia or a terminal septicaemia causing death. It was also noted that four of the six bats had swollen wrist joints. These were considered likely due to the small area in which they were held and the resulting lack of flying exercise (Heath *et al.* 1987).

The endemic wingless New Zealand bat fly, *Mystacinobia zelandica*, is often found on the short-tailed bat (Holloway 1976). It is not a parasite and feeds on bat guano for most of its life (Sedgeley *et al.* 2012).

Other bat species have occasionally arrived in New Zealand, usually in shipping containers but also following extreme storms (Duignan *et al.* 2003). Significant pathogens of bat origin are confirmed in Australia and elsewhere, including Australian Bat Lyssavirus, Hendra Virus, Nipah Virus, Menangle Virus, and Tioman Virus (Duignan *et al.* 2003). These are known risks to humans and other animals. Utmost care should be taken to minimise risks to personnel when attending to any bats that may have entered New Zealand from other countries. Duignan *et al.* (2003) provides a summary of the numerous potentially pathogenic viruses, bacteria, fungi, and protozoa found worldwide in bats[3].

2.3 Previous accidental deaths and injuries.

New Zealand bats are known have been injured or killed by:

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1 And presumably replaced, although this is not mentioned.

2 "Each bat was held by the skin at the back of the neck and the pyrethrum dust insufflated onto the fur and dispersed among the fibres as thoroughly as possible. The roost was also treated with the dust." (Heath *et al.* 1987 p.42)

3 http://www.sciquest.org.nz/node/47357

- Introduced mammalian predators, including dogs, cats, stoats, rats, and possums (Daniel and Williams 1981, 1984; O'Donnell 2000; O'Donnell *et al.* 2017).
- Indigenous predators, including ruru/morepork (*Ninox novaeseelandiae*, Daniel and Williams 1984).
- Tree felling or natural toppling of roost trees (K. Borkin, pers. obs.; Daniel and Williams 1984).
- Getting stuck in a barbed wire fence (Daniel and Williams 1984).
- Becoming stuck in a spring-tailed aerial (K. Borkin, pers. obs.).
- Collisions with vehicles (Moore 2001) or other objects: bats have collided with a shed and a television aerial during a storm (Daniel and Williams 1984).
- Presumed drowning: bat found in swimming pool (Moore 2001).
- Poisoning (Daniel and Williams 1984; Dennis and Gartrell 2015).

Short-tailed bats are vulnerable to poisons used to target introduced mammalian predators and deaths have occurred from cyanide (Daniel and Williams 1984) and Diphacinone (Dennis and Gartrell 2015). Sub-lethal poisoning by Diphacinone has been detected in short-tailed bats, with the toxin detected in milk found in the stomach of bat pups and maternal deaths have led to the likely starvation of dependent young (Dennis and Gartrell 2015). Pindone has been found in short-tailed bat guano and in the liver of five dead lesser short-tailed bats found in Pureora Forest; but it is unknown whether the toxin killed these bats (T. Thurley pers. Comm. Cited in Edmonds *et al.* 2017). One bat pup, with placenta still attached, was found dead under a roost tree and 1080 was found in its muscle tissue; again it is unknown whether the toxin killed this bat (Edmonds *et al.* 2017).

Bats held in captivity have also died from conditions that may have been related to being held (Heath *et al.* 1987, Sedgeley and Anderson 2000). Deaths of lesser short-tailed bats in captivity occurred due to septicaemia caused by self-scarification in response to infestation by a blood-sucking mite, *Chirolaelaps mystacinae* (Goudswaard *et al.* 1998, Heath *et al.* 1987[1]). Short-tailed bats died, apparently due to heat or panic stress, whilst being held in captivity on Codfish Island (Sedgeley and Anderson 2000). When in captivity on Codfish Island, one short-tailed bat was caught between a door hinge and the door frame. When the door opened the bat's wing was broken in two places, and the bat had to be euthanised (Sedgeley and Anderson 2000). Several short-tailed bats died during an attempt at induced hibernation that involved dropping their temperature in a domestic fridge – a technique used overseas (Lloyd and McQueen, undated file note). At least one of these bats was in poor and deteriorating condition prior to the induced hibernation (Lloyd and McQueen, undated file note). This may indicate the risks of allowing bats to enter torpor when injured.

Ear lesions have been known in several cases when short-tailed bats have been held in captivity. These have presented either whilst still in captivity (Wellington Zoo; Heath

[1] Described in greater detail in Section 2.2

et al. 1987; Goudswaard *et al.* 1998), or were noted during checks that took place after the bats were released (Kapiti Island; Ruffell and Parsons 2010). In the Kapiti Island example, bats displayed extreme ear necrosis and abscessation (Gartrell 2007). Partial amputations of their pinnae meant that bats were able to recover from the dermatitis but were unable to fly adequately within a darkened room, and were unable to be released (Gartrell 2007).

2.4 Basic bat biology

2.4.1 Torpor

Torpor occurs when bats reduce their temperature and metabolic state to below normal body temperature (Geizer 2004). This reduces the amount of energy required for normal activities (Wang and Wolowyk 1988). However, when bats are injured the use of torpor may slow healing and in the short-term may obscure injuries, such as severe bruising, by slowing their development (NSW WIRES Inc. 2018). Bats that are being assessed for injuries should, therefore, be kept warm and at relatively high humidity, to reduce the likelihood of entering torpor.

Short-tailed bats use torpor during summer and winter. During winter, short-tailed bats can be in torpor for several days, but also use short bouts of torpor during winter and summer (Czenze *et al.* 2016). This use of torpor - along with the use of different roosts at different times of the year - serves to minimise energy loss (Czenze *et al.* 2016).

Long-tailed bats are likely to use torpor in a similar way, but this has not been studied in any detail.

Both species can use torpor during the day, at any time of year, and this has implications for the assessment of health and the potential use of medication. For example, if bats are allowed to enter torpor, slowing of their metabolism may mean that healing is delayed and that medications are not metabolised or effective.

More information about torpor, and how to rouse bats from it, can be found in Appendix 6.

2.4.2 Breeding cycle

New Zealand bat species generally give birth in early summer. Dates for each stage of the breeding cycle may vary due to weather conditions, as has been found for European species (Linton and Macdonald 2018). In Australia, parturition dates for species in the same genus appear to vary with weather conditions (D. Eastick, La Trobe University, pers. comm., 30 April 2019). A general outline of the New Zealand bat breeding cycle is shown in Figure 1.

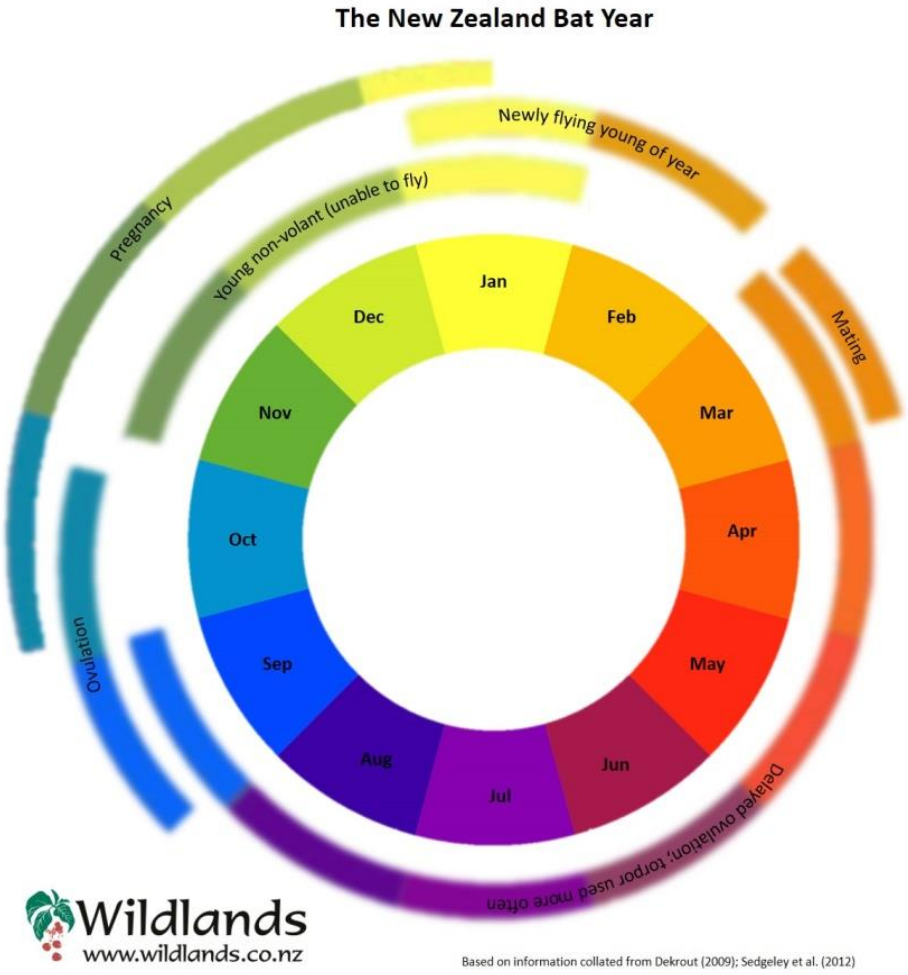

Figure 1: The New Zealand bat year, based on Dekrout (2009) and Sedgeley *et al*. (2012), showing important stages in the breeding cycle for both long-tailed bats and short-tailed bats.

A lactating female may have a dependent pup waiting in a roost for her return. However, the survival of the adult female should be prioritised over a pup (NSW WIRES Inc. 2018). If an adult female is released but is unable to provide for either herself or her offspring then this may result in the deaths of two bats (rather than one). Care of an adult female should always be prioritised.

3. BAT IDENTIFICATION

3.1 Which species?

One of the easiest ways to determine the species you are dealing with is to look at their tail. The long-tailed bat's tail and thin legs are completely enclosed in the tail membrane. In contrast, a short-tailed bat's tail is emergent from the membrane and its legs are far more muscular than a long-tailed bat (see Figure 2 and Plates 3, 4, and 5).

The ears of a short-tailed bat are pointy, whilst the ears of long-tailed bats are more rounded (See Figure 2 and Plates 3, 4, and 5 for a comparison).

Plate 3: Long-tailed bat in flight. Note the v-shaped membrane between the legs, and the legs are relatively thin compared to a short-tailed bat. Photograph: Chris Hillock Photography.

Plate 4: Short-tailed bat in flight. Note the muscular legs and the membrane between them. Photograph: D. Mudge.

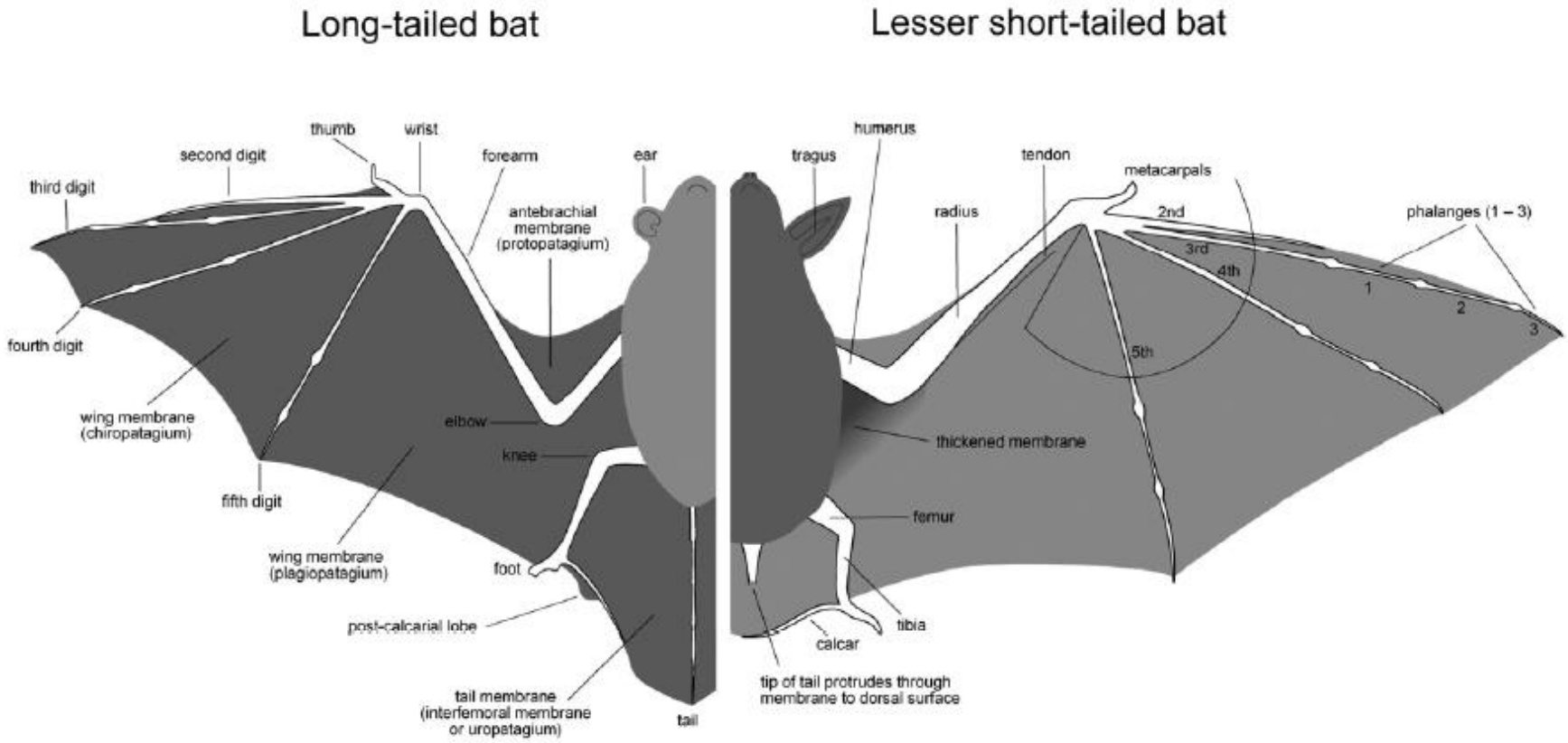

Figure 2: Main features of the long-tailed bat and lesser short-tailed bat. Reproduced with permission, Department of Conservation best practice manual of conservation techniques for bats, Sedgeley *et al.* (2012).

Plate 5: Short-tailed bat on a forest floor amongst *Dactylanthus taylorii* flowers. Note the pollen around its nose and mouth. Wings are furled to walk on the forest floor. Photograph: D. Mudge.

3.2 What sex is this bat?

Male bats have a relatively conspicuous, pendulant penis. Female bats have nipples located near the armpit, which are more conspicuous when they have recently given birth (Sedgeley *et al*. 2012).

Plate 6: Adult female long-tailed bat shown with wing extended to reveal a dark brown nipple near the armpit, surrounded by fur. Photograph: Chris Hillock Photography.

3.3 How old is this bat?

To determine the age of the bat it is most reliable to examine finger joints and assess their degree of ossification (Sedgeley *et al.* 2012). When bat pups are non-volant (i.e. unable to fly) and when they first begin to fly (as juveniles), their finger joints appear hollow due to the presence of cartilage when torch light is used to backlight the joint. This changes quickly and by about 12 weeks of age their finger joints are more knobbly and solid, and are difficult to differentiate from those of adults (Sedgeley *et al.* 2012).

Non-volant, hairless, pups are most likely to be found over the summer months of November - January (refer to Figure 1). Pups of this age are dependent on their mothers for milk and will therefore require milk formula when in care. They are also likely to be unable to thermoregulate (NSW WIRES Inc. 2018).

Juvenile bats are furry, able to fly, and most likely to be found from November-January (Sedgeley *et al.* 2012; Figure 1). Juvenile bats may still suckle from their mothers, but this is also supplemented by their own foraging. Young bats may be unable to fly until they are 90% of adult skeletal size and 70% of adult body weight (R. Lyons, Wildcare, pers. comm., 27 May 2019).

Plate 7: Non-volant, hairless, short-tailed bat pup born at Auckland Zoo. Photograph: Debra Searchfield, Auckland Zoo.

Refer to Sedgeley *et al*. (2012) for more detail:

https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventory-monitoring/im-toolbox-bats/im-toolbox-bats-doc-best-practice-manual-of-conservation-techniques-for-bats.pdf

4. INITIAL TRIAGE PROCESS

4.1 Does the bat need care?

If the bat was found in any of the following circumstances then it must be checked by a veterinarian and is likely to need care:

- It is found on the ground during the day.
- It was seen being attacked by another animal, such as a cat.
- It was in a tree that has been felled.
- It is likely that an incident has taken place, resulting in an injury to the bat.
- It was trapped or caught in something.
- There are obvious injuries.
- It is unresponsive or unconscious. Please note that bats do go into torpor - a reduced metabolic state - particularly if the weather is cold. Bats still breathe when in torpor, although at very slow rates (Morris *et al.* 1994).
- Note that if the bat is inside a building it may just need assistance to escape (bats are known to use attics as roosts overseas and have been found in a building in New Zealand, Daniel and Williams 1984). If mobile, open up all windows and doors and turn off lights, so that the bat has the opportunity to fly outside by itself. If this is not successful, wait until the bat has landed then quickly place a cloth over the bat, carefully scoop it up and put it in a box that can be closed securely. Place the box outside, away from domestic animals and people, and let the bat emerge from the box in its own time. Do not swipe at the bat with a net as this may result in injury. If it is possible that the bat has been in the building for some time, i.e. several days or nights, then they should be checked by a vet for dehydration and other injuries.

4.2 Handling and collection

4.2.1 Precautions, hygiene, and the use of gloves

Whilst there are no records of transmission of diseases or viruses from bats to people in New Zealand, anyone handling bats should take care to avoid being bitten and to maintain hygienic practices (Sedgeley *et al.* 2012). Wearing of gloves is advisable when handling New Zealand bat species but is not considered mandatory because their use may increase clumsiness by the handler and the risk of injury to the bat (Sedgeley *et al.* 2012). The Department of Conservation best practice manual suggests that "*A good compromise is to wear a single relatively thin glove on the hand used to control the bat, and keep the hand used for manipulation purposes bare*" (Sedgeley *et al.* 2012, Page 85). Nitrile gloves are generally considered more robust than standard disposable gloves and therefore may be better suited for veterinary procedures, particularly when being there is the potential to be bitten. Nitrile gloves will not prevent the bite, but may allow the bite site to be identified for treatment because they are less likely to split than standard gloves. If bitten, NSW WIRES Inc. (2018) suggests gently washing the wound for 15 minutes with soap under running water. This should be a "wash and flush" approach. Do not scrub the wound, to ensure that debris is not pushed further into the wound. Betadine should be applied after washing.

People who regularly handle or care for bats should be vaccinated for rabies as a precaution, although this is not currently known to be present in New Zealand (K. McInnes, Department of Conservation, pers. comm., 27 March 2019). Unless there is an incident where transmission is considered likely, rabies antibody titer levels should be checked every two years, to ensure that levels are greater than four (Dr Tania Bishop, Australia Zoo, pers. comm.).

4.2.2 Collection methods

Ideally, the bat should be placed in a cloth bag in a dark, quiet place at ambient (or slightly warmer) temperature and taken to a veterinarian for assessment as soon as possible[1]. A maximum of two bats should be kept in one bag (Appendix 2).

If you do not wish to handle the bat, and it is on the ground, place a cardboard box over it for protection, exclude domestic animals such as cats and dogs from the vicinity, and contact the Department of Conservation for advice/assistance on 0800 DOCHOT (0800 362 468)[2].

When handling the bat, care must be taken to not strain its wings, forearms, or flight muscles (Sedgeley *et al.* 2012). Handling should be kept to a minimum, to minimise stress.

4.2.3 Transport

- The bag must be secured during travel.
- Time spent transporting the bat should be kept to a minimum.
- Call ahead to the vet clinic to ensure that they are willing to care for a bat.
- Avoid diversions (e.g. don't go to the supermarket!).
- Keep the vehicle interior quiet (don't play loud music or talk loudly to passengers).
- Drive smoothly and carefully.
- Ventilate the car adequately as temperatures climb quickly in cars on hot days.
- Label the container/bag with "Live Bat".
- Let someone know that you are transporting a bat, in case of an accident (NSW WIRES Inc. 2018).

[1] The following was prepared for New Zealand forestry crews that are unlikely to have spare cotton bags handy: *"...put it in a cool, quiet, dark place, preferably in a cotton bag. If you don't have a cotton bag, then you might be able to tie up an old t-shirt and pop the bat into it. Wet the corner of the bag by dipping it into some water, and then hang the bag in a cool, quiet, dark place. Heat makes bats more active and burns through their energy quickly. Wetting the corner of the bag gives them water to drink."* (Borkin 2018). This recommendation differs slightly from that provided by Wildcare (R. Lyons, Wildcare, pers. comm., 27 May 2019), i.e. that ambient or slightly warmed temperature is best so that bats do not enter torpor.

[2] Advice provided for Department of Conservation Duty Officers is set out in Appendix 2.

4.3 Record the history

Recording of a detailed history is critical to help understand what injuries, if any, the bat may have. A good way to compile a history is to answer the following questions:

- What time of day and date was it found?
- Where was it found?
- Who found it (and their contact details)?
- What was it doing when found?
- What species is it, if known?
- What is its age (does it have hair?) and sex (male bats have an obvious penis)?
- Were other bats present?
- What happened/had just happened when it was found?
- If there has been a delay between the bat entering care and when it was found, what has happened over that time and where has it been previously?
- Has it had any treatment?
- Is it demonstrating any abnormalities, e.g. obvious broken bones, vocalisation, wing tears, puncture wounds?

It may be useful to obtain an x-ray, to assist with an accurate assessment of injuries.

4.4 Assessment of condition/injuries

Bats should be kept for assessment for at least three days (72 hours) and should not be allowed to enter torpor during this time (Lyons and Wimberley 2014; NSW WIRES Inc. 2018). During this first three days, bats should be checked daily for any changes in condition (Lyons and Wimberley 2014). This is because injuries may not be apparent for at least 24 hours, and possibly longer, and may develop slowly when bats are allowed to enter torpor[1]. The only exception would be, for example, if a bat flew into a building and was unable to escape without help (Lyons and Wimberley 2014). Even bats that may be able to fly should be assessed for injuries.

A full body sweep must take place to check for injuries, and this should be undertaken by a trained veterinarian.

Addressing hydration of the bat should begin at this point (See Section 9 for a full description of re-hydration techniques).

[1] This could occur at temperatures of less than 30^0C (NSW WIRES Inc 2018).

5. HOLDING WILDLIFE FOR REHABILITATION

Rehabilitation of protected wildlife is managed by Department of Conservation under the Wildlife Act 1953. Persons undertaking protected wildlife rehabilitation require a Wildlife Act authority (permit). Direction should be taken from the Department of Conservation in all cases. See https://www.doc.govt.nz/get-involved/apply-for-permits/interacting-with-wildlife/holding-wildlife-for-rehabilitation/ for more information.

6. USE OF DRUGS

All drug use for wildlife is "off label" due to lack of registration of drugs for such use, and requires veterinary discretion. General guidance for drugs and dose rates for use with bats has been provided in Appendix 1.

7. USE OF GENERAL ANAESTHESIA FOR TREATMENTS

Using a short Isoflurane general anaesthesia is very useful when handling bats for treatment. It will reduce stress on the bat, enable a more effective treatment and reduce risk of any additional injury. It is frequently used for procedures such as removing entangled netting, x-rays, and wound cleaning. It avoids the need for prolonged handling of the bat, and reduces risk of bites to the handlers.

8. EUTHANASIA

The definition of euthanasia is "good death". If an animal cannot be returned to full pre-capture fitness, then welfare issues are likely and euthanasia is the most humane choice. Animals kept with injuries can suffer from life-long chronic stress, pain, and associated systemic illness, which can be difficult to assess.

Wild animals need to be fully fit to be able to survive after release. Anything less than this will lead to welfare issues.

Euthanasia should be considered early in the process. The decision to euthanise should be undertaken in consultation with the Department of Conservation and be supported by a veterinarian, if available, and decisions should be made on a case-by-case basis. Once the decision to euthanise has been made this should be undertaken without delay.

Wildlife that are unlikely to be releasable to the wild should be euthanised. Bats with a reasonable chance of recovery within three months can be rehabilitated by a permitted rehabilitator. If recovery requires longer time in care then the Department of Conservation must be consulted to seek approval for an extension.

NSW WIRES Inc (2018) bat manual suggests that:

> "*Euthanasia is a good outcome for bats whose injuries will lead them to be unable to survive in the wild or who are in unmanageable pain. Euthanasia is not a failure* (Page 156)."

<u>Factors to Take Into Account When Weighing Up the Future of the Bat</u>

- Is there a carer who is able and willing to look after this bat in the long-term, i.e. several months? Carers may be required to have their facilities/situation inspected by the Department of Conservation, and a permit may be required under the Wildlife Act (1953). Direction should be taken from the Department of Conservation in all cases.
- Are there facilities available *e.g.* incubator, care team?
- Is there a flight aviary suitable for bats for flight rehabilitation and to build up fitness prior to release?
- What will the future of this bat be? e.g. permanent captivity, long-term pain, quality of life?

Injuries/Situations for Which Euthanasia Should be Considered Include

- Injuries are terminal.
- The bat cannot roost, eat, or fly.
- Bat is in constant pain.
- Internal bleeding.
- Major organs are exposed.
- Signs of poisoning: fitting, screaming, difficulty swallowing, foaming at the mouth.
- Neurological trauma.
- Fractures of large wing bones, clavicle, knee, elbow, wrist, shoulder, pelvis, spine, head (Lyons and Wimberley 2014; Miller 2016; NSW WIRES Inc 2018).
- Long term care is required but is not available.
- Permanent captivity is likely.

Treatment

- The bat should ideally be under full surgical anaesthesia prior to euthanasia.
- As IV access can be difficult, intra-organ injection of barbiturate is a good option. The volume of barbiturate overdose required will be higher than 'normal' use of the intravenous technique.
- Carefully palpate the body to locate either the heart or the liver.
- Aim the injection into the heart or liver under the rib cage, at the top of the abdomen or the base of the sternum.
- Ensure that the animal is deceased by monitoring heart rate and breathing.

9. HYDRATION

9.1 Overview

Most bats taken into care are likely to be dehydrated and management of fluid intake will be required (Lyons and Wimberley 2014; NSW WIRES Inc. 2018). Taking bats into care, even only for one day, as occurs occasionally during routine bat capture operations as part of conservation work, may require hydration management. This is because bats may experience damage to the renal system if dehydration occurs over an extended period. The onset of dehydration can occur quickly, and may not be obvious, at least initially.

Australian bat care manuals suggest rehydration by sub-cutaneous fluid injection (Lyons and Wimberley 2014; NSW WIRES Inc. 2018). British bat care manuals do not suggest this approach (Miller 2016) because of the risks to people of needle stick (R. Lyons, Wildcare, pers. comm., 27 May 2019). However, this risk is considered to be low for trained personnel. In addition, because New Zealand's long-tailed bat is closely related to Australian species (the same genus, *Chalinolobus*), so Australian guidelines may be useful for New Zealand species.

9.2 Does the bat require rehydration?

Visual indications of potential dehydration are:

- Wings and/or skin look dry and papery like crepe paper (moderate dehydration).
- Tenting of skin.
- Skin doesn't move back and forth smoothly. Test this over back or sternum.
- No urine output (extreme dehydration).
- Exposure ulcers in eyes (extreme dehydration; due to the watery component of the tear film drying up).
- Gums are pale (extreme dehydration). Use other parameters due to the likelihood of being bitten.
- Neurological symptoms such as loss of coordination, seizures, and loss of consciousness (extreme dehydration; NSW WIRES Inc. 2018).

Indicators of full hydration are:

- Sub-cutaneous fluids are not readily absorbed (NSW WIRES Inc. 2018).
- Wings are not dry and papery.
- The bat urinates freely upon handling (NSW WIRES Inc. 2018).

Most bats that are not released on the same night that they are captured/rescued will require hydration management. Most bats should receive 5% of their body weight in sub-cutaneous fluids, even if they do not appear to be dehydrated. This can help with conditions that may not be immediately noticeable at first triage, as well as dealing with stress of capture and assessment. Bats in shock require warm fluids in high quantities (NSW WIRES Inc. 2018). In general, oral fluids alone are not considered adequate for rehydration (NSW WIRES Inc. 2018).

9.3 Rehydration methods

9.3.1 Overview

There are three potential methods: oral, sub-cutaneous injection, and intra-peritoneal injection, as described below. Bats need to be warm and out of torpor prior to rehydration. Fluids need to be warmed to body temperature for all methods.

9.3.2 Oral hydration

Bats will need to be conscious and drinking for this method to be used. It has the benefit of being considered to be a positive experience for bats, so may reduce stress, and requires little training (NSW WIRES Inc. 2018).

This is slower than methods such as the injection of sub-cutaneous fluids because the combined surface area of the mouth, throat, and stomach is significantly smaller than that reached by the sub-cutaneous or intra-peritoneal injection of fluids.

9.3.3 Injection of sub-cutaneous fluid

During sub-cutaneous injection, sterile fluid is injected under the skin and is absorbed by the tissue under the skin (NSW WIRES Inc. 2018). The usual site for injection is under the loose skin between the shoulder blades (NSW WIRES Inc. 2018).

The bat will need to be out of torpor for any invasive veterinary care to take place, including sub-cutaneous injections.

This method requires training, and is not effective if the bat is in circulatory collapse (NSW WIRES Inc. 2018). Untrained people should not re-hydrate using this method.

Bat pups may need to have sub-cutaneous injections of fluids every 3-5 hours during at least their first week in care (H. Caulfield, NSW WIRES Inc., pers. comm.). This needs to be assessed at each feed and depends on their level of hydration.

Technique for Sub-Cutaneous Injection of Fluids

The following is from NSW WIRES Inc. (2018, pp 106-107).

- Should only be used on a warm bat (can be used to warm a bat if fluids are warm).
- [Fluid amounts: aim to give 15-20% or more of body weight in fluid over the first 24 hours (half in the first 6 hours)]
- Use Hartmann's solution - it must be sterile and in date.
- Should be discontinued once the bat is properly hydrated.
- Immerse the IV bag in warm water. Leave the port (the end we stick the needle in) out of the water. We are aiming for the injection fluids to be around 38.5^0C - it should feel warm but not hot (use a thermometer).
- Wash hands, draw up fluids using a drawing-up needle (e.g. 19 gauge) into a sterile syringe, exchange for an injecting needle (25 gauge) on the end.
- On the bat, identify the injection sites where there is loose skin over the shoulders and hips.
- Wrap the bat so that the chosen bit of skin is exposed and the bat is comfortable and safe.
- Choose a site and swab fur and skin with iodine.
- Remove the needle cap and check the temperature of the fluids by squirting a little onto your skin. It should be blood temperature - not hot.
- Pick up skin until it makes a 'tent, and carefully insert tip of needle, bevel up and into skin at the widest part of the tent, close to the body. If you go too far the needle and fluid will come out the other side.
- Very slowly, inject 5-10% of body weight - multiple sites may be needed to inject this amount of fluid. You will know when too much has been injected into any given site when it starts to leak out.
- Withdraw needle, remove needle from syringe and dispose of directly into sharps container.

Rehydration of short-tailed bats has involved subcutaneous injection of fluid: 0.9% NaCl/2.5% glucose (Dennis and Gartrell 2015). An alternative could be the use of 0.45% NaCl/2.5% glucose (Figure 3, Dr Tania Bishop, Australia Zoo, pers. comm. 23 May 2019). Once opened, glucose solutions should be refrigerated.

Figure 3: 0.45% Sodium chloride/2.5% glucose solution (Image from https://www.medshop.com.au/products/baxter-045-sodium-chloride--25-glucose-iv-soln-500ml Downloaded 25 May 2019).

There is an excellent video demonstrating this technique for birds at https://www.doc.govt.nz/globalassets/system/training-courses/wildlife-health-8/index.html

Hartmann's solution[1] is likely to be better than saline because it is biocompatible with the type of injuries that are likely to occur (Dr Tania Bishop, Australia Zoo, pers. comm. 23 May 2019, Figure 4). Long-term use of saline solution creates an imbalance in electrolytes and also a blood acid-base imbalance.

Association with dehydration: to prevent worsening of exposure ulcers in the eyes due to dehydration, false tears or genTeal gel can be purchased from a chemist and administered. Note that this does not address dehydration itself, only an associated condition and does not treat already established ulcers.

Figure 4: Hartmann's solution (Compound Sodium lactate). Image from https://www.ahns.com.au/product/solutions/sodium-lactate-hartmanns-solution-1-litre-each/ (downloaded 25 May 2019).

9.3.4 Intra-peritoneal injection

Intra-peritoneal injection of fluids involves the injection of a large amount of sterile fluid into the abdominal cavity and allows quick uptake of fluid (NSW WIRES Inc. 2018). However, it quickly becomes ineffective with use, is technically difficult, and requires special training (NSW WIRES Inc. 2018). For these reasons, it is not suggested for use with New Zealand bats.

[1] *Hartmann's solution* or compound sodium lactate (CSL) is a crystalloid *solution* that is most closely isotonic with blood. *Hartmann's* IV Infusion is used to replace body fluid and mineral salts that may be lost for a variety of medical reasons. https://www.ahns.com.au/product/solutions/sodium-lactate-hartmanns-solution-1-litre-each/ downloaded 25 May 2019, See Figure 4 for image).

10. BASIC CARE AND HOUSING

10.1 Initial care

10.1.1 Treatment of common injuries

Information in this section relies heavily on NSW WIRES Inc. (2018), Lyons and Wimberley (2018), Miller (2016), and advice from Dr Tania Bishop (Australia Zoo), and is focused on the treatment of common injuries only. Advice should be sought for more complicated conditions or injuries. See Section 13 below for more information on where/how to obtain additional advice.

> For bats "*hypoglycaemia, hypothermia and dehydration due to their fast metabolic rates are the most common physiological conditions that need to be addressed when creating a therapeutic plan post rescue."* (Bishop 2018, Page 1).
>
> "*The extreme cortisol output seen with acute pain causes immunosuppression and delayed healing as well as a catabolic state and extreme stimulation of the sympathetic nervous system, a problem augmented in patients with high metabolic rates [i.e. bats]. It can also potentially lead to magnification of pain perception, shock and death."* (Bishop 2018, Pages 1-2).

Bats are likely to consider people to be predators. Minimising stress and reducing metabolic requirements are therefore important, so that they can direct their remaining resources to healing. This requires the provision of appropriate ambient temperatures, high energy food, sufficient fluids, hiding spaces, and appropriate pain relief. The metabolic rate of the animal and the percentage of the body that is affected should be considered during all treatment.

Throughout all treatment, bats will need to be kept warm and out of torpor. This is to ensure that treatment is effective, and that medication does not become toxic. As a general rule, some care organisations recommend keeping bats warm and out of torpor for three days post-medication (R. Lyons, Wildcare, pers. comm., 27 May 2019).

Any fly eggs or maggots should be removed carefully. The application of any medicines or other items to skin should be considered carefully as they may be consumed during grooming.

In almost all cases the initial treatment should be to administer sub-cutaneous fluids and replacement of glucose. In nearly all situations, at first 10% of body weight sub-cut fluids of 50:50 Hartmann's solution: 2.5% glucose/saline solution.

In cases of severe dehydration, Hartmann's solution can be given at 10% body weight with 2.5% glucose/saline given as an added 5% of body weight for energy (total of 15% of body weight). For example, for a 10 gram bat 10% body weight would equate to 1 ml of fluid administered sub-cutaneously, i.e. 0.5 ml glucose solution: 0.5 ml of Hartmann's solution.

Giving sub-cutaneous fluids to a rescued bat is never the wrong thing to do (Dr Tania Bishop, Australia Zoo, pers. comm., 23 May 2019).

X-rays should be taken as a standard part of the veterinary evaluation of any sick or injured bat due to the high frequency of fractures/pneumonia/peritonitis from predation incidents and the difficulties in diagnosis of these conditions grossly prior to a terminal state.

Whilst checks have been made, some of the products mentioned in this section may not be readily available in New Zealand and similar alternatives should be substituted after careful evaluation. All use is off-label due to the lack of official testing in bat species (Bishop 2018).

It should be noted that minor tears in the wing membrane occur relatively frequently and may heal naturally.

Bruising

Bruising should be assumed to be present if there is a history of impact/entanglement. Analgesic and anti-inflammatory treatment is suggested (Lyons and Wimberley 2018). Lyons and Wimberley (2018) suggest the use of Metacam®, with sparing use of Traumeel® topically where there are no skin ruptures. Aspirin is not recommended (Lyons and Wimberley 2018). Bats should be well hydrated prior to the use of Metacam®. The Metacam® dose rate for bats is usually 0.2mg/kg injectable and oral (Dr Tania Bishop, Australia Zoo, pers. comm., 2 August 2019). Fluid therapy is critical in cases of bruising, to manage tissue necrosis factors and help flush them from the body via the kidneys.

Bite Wounds or Other Punctures

Bats will often have to be euthanised if they have bite wounds due to issues arising from bites (NSW WIRES Inc. 2018). These can include infections, fractures, tearing of

ligaments, and neurological damage due to the bat being shaken (NSW WIRES Inc. 2018).

Clinical Signs

- Punctures.
- Holes in wings.
- Bruising and swelling (NSW WIRES Inc. 2018).

Treatment May Require

- X-ray to determine whether fractures are present.
- Cleaning of the wound using saline, Chlorhexidine, or Betadine, or similar.
- Application of a suitable antibiotic - this may include surface application (topical).
- Cold packs to reduce swelling (NSW WIRES Inc. 2018).
- For cat bites pasteurella, a gram negative anaerobe, is carried on their claws and teeth so wounds are often closed by the time rescue occurs. If cat attack is suspected then treatment should include an antibiotic to address this. For example, Enrofloxacin (Baytril) at 5mg/kg sub-cutaneous once a day should be given as soon as possible. Fluid therapy is also very important with these bacteria as they often cause septicaemia.

Bloat

Bloat is the build-up of gas in the stomach. It is more likely to occur with an incorrect diet, but may also occur with abdominal blockage (NSW WIRES Inc. 2018; Lyons and Wimberley 2018). Use of cows' milk-based formula has been associated with bloat in Australian bats, and goats' milk-based formula should be used (Lyons 2018).

Dehydration and hypoglycaemia are key causes of gut stasis, so treatment should always begin with addressing this as well as warmth. Bloat often occurs due to over-feeding and/or dehydration along with gut flora imbalance.

Clinical Signs

- Rigid stomach.
- Abdominal swelling.
- Change in appetite.
- Dry whitish faeces.
- Signs of pain.
- Straining (NSW WIRES Inc. 2018).

Treatment May Require

- Sub-cutaneous fluids, including glucose, and warmth.
- Discontinue feeding, substitute with cool boiled water and possibly Infacol (NSW WIRES Inc. 2018).
- Faecal dif qik/gram stain is important if this is possible. If *Candida* are detected, treatment with Nystatin should begin at 50 000 IU/kg twice daily orally. *Candida*

can usually be observed in the 40× lens of the microscope. This is very similar in appearance to *Malassesia* species of yeast seen in the skin conditions of domestic pets (Dr Tania Bishop, Australia Zoo, pers. comm., 23 May 2019).
- Consider an x-ray in case of blockage/stomach torsion has occurred.
- Consider euthanasia if no improvement occurs within 24-36 hours (NSW WIRES Inc. 2018).

Entanglement

This may be apparent from the history of the bat. In New Zealand, bats have been previously entangled in spring-tailed aerials with resulting tears in the wing membrane (K.B., pers. obs.), and in barbed wire, resulting in eventual death (Daniel and Williams 1984).

Clinical Signs

- Fractures.
- Bruising.
- Swelling.
- Dead membrane.
- Exposed/dead bone.
- Lacerations.
- Ligament or tendon damage (NSW WIRES Inc. 2018).

Treatment May Require

- Removal of all entangling material.
- Rehydration.
- Treatment for other associated injuries, e.g. fractures, punctures (NSW WIRES Inc. 2018).

Complications from Entanglement and Crush Injuries

Clinical Signs

- Myopathy (rhabdomyolysis) leading to kidney and often multi-organ failure.
- Kidney failure.
- Circulatory collapse.
- Neurological problems.
- Gut stasis (when the digestive system slows or stops completely).
- Inability to urinate voluntarily (NSW WIRES Inc. 2018).
- Pain.
- Severe stiffness.
- Damage to large proportion of the body.

Treatment May Require

- Fluid therapy using rehydration fluids to flush the myoglobin from the system to minimise renal damage.

Exposed Bone/Tendon

Clinical Signs

- Exposed bone or tendon.

Treatment May Require

- Clean and cover as soon as possible, to avoid the exposed area drying out.
- X-ray for potential fracture.
- Clean with diluted Betadine or Chlorhexidine solution.
- Dry and put Solosite or Flalminal Hydro on exposed area to keep moist then cover with Comfeel or Duoderm thin (NSW WIRES Inc. 2018). An antibiotic cover is important such as Amoxicillin/clauvulanic acid at 12.5-20 mg/kg once a day if injectable or twice a day if oral.
- Good multi-modal pain relief is imperative that is appropriate to the injury (see Section 10.1.2).

Fractures

X-rays may be required to diagnose some fractures, particularly when these are closed. The broken clavicle of the adult long-tailed bat shown in Plate 8 was diagnosed using an x-ray.

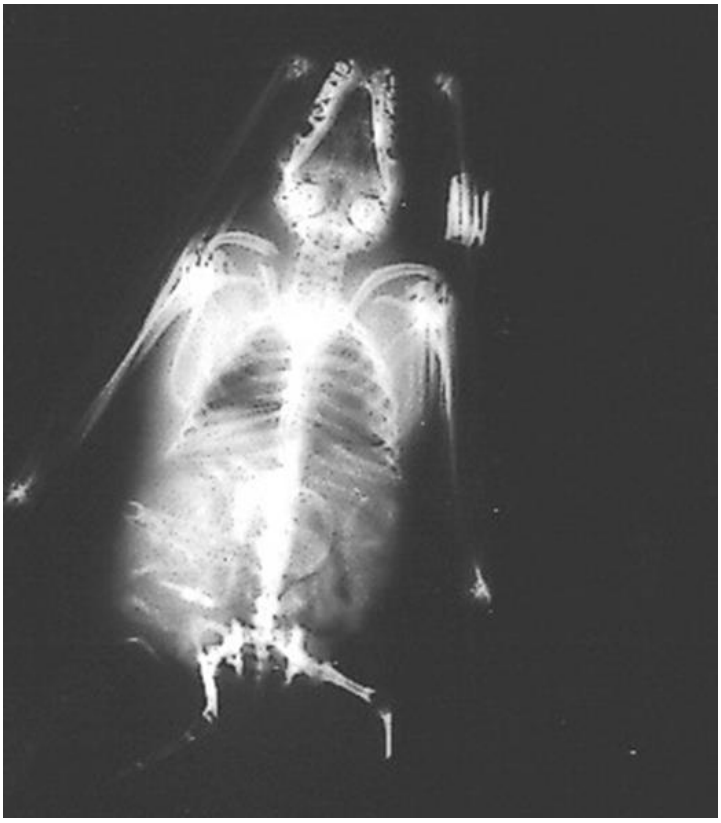

Plate 8: Note the fractured right clavicle of this heavily pregnant adult female long-tailed bat. The injury resulted from felling of their roost tree. Image: K. Borkin collection.

Fractures of some long bones can be treatable depending on the nature of the bat, concurrent injuries, and availability of experienced carers for up to 4-6 weeks of care whilst the bat heals prior to the rehabilitation process. Rehabilitation includes the building up of flight fitness and may take several months. Availability of care needs to be considered prior to treatment. If adequate care, pain relief, and rehabilitation are not possible then euthanasia is the only humane option.

Clinical Signs

- Obvious fracture or deformity.
- Internal bleeding.
- Bat appears "uneven".
- Drooping wing.
- Dragging feet (Lyons and Wimberley 2018).
- Unable to hang or use limbs (Miller 2016).

Treatment May Require

- Euthanasia, particularly if it is a larger bone.
- Pain management.
- Good multi-modal pain relief is imperative that is appropriate to the injury.
- Treatment with antibiotics.
- Pinning by an experienced veterinarian.
- Long-term care. This may require several weeks of stabilisation.
- The use of a flight centre for flight training and to rebuild fitness.
- Fitness testing prior to release (Lyons and Wimberley 2018; Miller 2016).

Note that wounds usually need to be less than 24 hours old in order to have a chance of repair (Lyons and Wimberley 2018).

Miller (2016) provides a summary of likely outcomes of fractures:

Is it a simple or compound fracture? The prognosis for compound fractures being much poorer.

- Will it regain full mobility?
- Substantial fracture repairs carry poor prognosis for release.
- Surgical procedures (pinning) require a certain amount of veterinary experience and skill to be successful and are only appropriate for the longer forearm bone.
- Other than minor amputations of the tips of bones in the wing, no amputee would be fit for release. Amputation can also cause problems with grooming, mobility and roosting and may cause stress through phantom appendages and is not therefore recommended.
- Simple fractures may heal if restricted but care is needed because of the delicate wing membrane. Bats are inclined to remove anything attached to the membrane causing complications.
- Juvenile bats heal more quickly than adult bats.
- Finger bones have more chance of healing sufficiently for release. Bats have been observed in the wild with naturally healed finger bones.

Head Injuries

Clinical Signs

- Bleeding from ears or nose.
- Hard palate is fractured.
- Swelling.
- Neurological symptoms such as walking in circles, favouring one side, uncoordinated, loss of consciousness (NSW WIRES Inc. 2018).

Treatment May Require

- Hydration using sub-cutaneous injection.
- Pain relief and anti-inflammatories can help in some cases.
- During first three days, keep warm, quiet and hydrated in intensive care housing. If no improvement consider euthanasia.
- If improvement is seen over the first three days, continue care for three weeks.
- If bat is unable to eat, groom, and hang independently after three weeks, consider euthanasia.
- If there is no long-term care available, consider euthanasia.

Membrane Damage (Physical)

Physical membrane damage may recover, particularly if holes or tears are small and at the periphery of the wing. Check carefully for other associated injuries. Prevention of infection is critical for membrane damage.

Clinical Signs

- Holes/tears in wings.

Treatment May Require

- Clean edge of hole/tear with saline or chemical debride (such as Epi-Otic®) until new tissue is visible. Cover with Tegaderm. Change every three days (NSW WIRES Inc. 2018).

- Massage with Ungvita or a suitable oil when changing dressing to help break down scar tissue. As scar tissue increases, stop dressing and continue with daily massage. Manage contracture if this occurs (NSW WIRES Inc. 2018).

- Topical application of Hirudoid cream or Neotopic H/Neocort (local anaesthetic with Cortisone and antibiotic agent in it which helps with preventing infection) and good hydration can help reduce blood clots and increase blood supply to membranes

(NSW WIRES Inc. 2018). Neotopic H is more absorbable than Neocort, which tends to leave an oily film. Flamazine can also be useful.

- Suturing/stitching is not advisable as this may cause further injury and bruising (Lyons and Wimberley 2018).

Miller (2016) provides the following synopsis of likely outcomes with physical wing membrane damage (tears/holes):

> "Small holes heal very quickly. Larger holes and tears require longer rehabilitation with flight facilities. The bat may need to be passed to a carer with appropriate facilities.
>
> Tears: If with gentle manipulation the membrane appears to be 'complete' (the sides match up) healing is more likely.
>
> If the tear is alongside the finger bone (often the fifth finger) it is likely to heal but if the finger bone is completely de-gloved (exposed) infection is likely and the prognosis is poor. If part of the finger bone has been amputated (particularly, for example, below the last knuckle of the fifth finger) the membrane may heal but loss of further bone may limit flight.
>
> With large tears, the resultant scar tissue/contraction of the wing may preclude perfect flight."

Pneumonia

Pneumonia can be very subtle.

Clinical Signs

- Quiet, weak animal.
- X-ray is required for early diagnosis to allow intervention.
- Increased respiratory effort is rarely, if ever, appreciated until disease is very advanced.
- Rarely able to auscultate (listen for) crackles/wheezes, as occurs with other animals.

Treatment May Require

- In most cases, nebulising with Baytril (Enrofloxacin 50mg/ml injectable and saline 1:5 solution) or 1:5 Gentamycin and saline solution for 20 minutes twice daily is the best first line treatment.
- If opening the airways is necessary, then Salbutamol can be administered (2.5 mg Nebule at 50:50 with saline.
- Administer antibiotics systemically as appropriate.
- Administer short-acting corticosteroids as appropriate i.e. Solucortef 50 mg/ml 5mg/kg sub-cutaneously once; or Redipred oral 5 mg/ml 0.5-1 mg/1 kg orally twice daily for two days then once daily for 2 days then every second day to wean off.

Poisoning

If poisoning is likely to have occurred, then this knowledge will drive treatment. Clinical signs will vary subject to the toxin ingested.

Clinical Signs

- Convulsions.
- Vomiting (Lyons and Wimberley 2018).
- Bruising and/other internal bleeding.
- Bleeding from orifices including mouth and/or anus.
- Dehydration.
- Starvation.
- Lack of vigour.
- Lethargy (Dennis and Gartrell 2015).
- Muscle weakness.
- Excessive drinking and/or urinating.
- Diarrhoea, sometimes bloody (Morrow 2001).

Treatment May Require

- Rehydration, particularly sub-cutaneous injection (Dennis and Gartrell 2015).
- Treatment will depend on the toxin that has been ingested. If the toxin is known, refer to the Material Data Safety Sheet (MDSD or Safety Data Sheet, SDS) for advice[1].

Anticoagulant Poisoning

Short-tailed bats have been poisoned by the toxin Diphacinone, an anticoagulant rodenticide (Dennis and Gartrell 2015). Anticoagulant toxins cause fatal haemorrhaging by interfering with the production of vitamin K-dependent blood clotting factors in the liver (Watt *et al.* 2005). The route of transmission may be by either direct consumption or, for secondary anticoagulants, by consumption of prey which have eaten the toxin, or possibly consumption of milk by dependent young (Dennis and Gartrell 2015).

The following treatment of Diphacinone poisoning took place at Wildbase Hospital, Massey University, Palmerston North and successfully rehabilitated three bat pups which were eventually released near where they were first found (Dennis and Gartrell 2015):

Treatment (Dennis and Gartrell 2015)

- Bats were kept warm during treatment.

[1] The following website provides a search engine for a large number of Material Data Safety Sheets https://www.msdsonline.com/ It is a requirement of a toxin user to have these sheets readily available for people who handle, or are exposed to the hazardous substance e.g. emergency workers, so if the toxin and the user is known then they should have available the Material Data Safety Sheet (Worksafe Mahi Haumaru Aotearoa https://worksafe.govt.nz/topic-and-industry/hazardous-substances/managing/safety-data-sheets/ downloaded 3 May 2019).

- Initial rehydration was undertaken using warmed subcutaneous fluid injection (0.9% NaCl/2.5% glucose), twice daily.
- Initial dosing with sub-cutaneous vitamin K (Konakion, Roche, Auckland, New Zealand) at 10 mg/kg twice daily.
- Bats then received 10 mg/kg oral vitamin K solution twice a day, prepared by a compounding pharmacist.
- Treatment with vitamin K continued for 34 days.
- General rehabilitation continued for a further three weeks.

It appears that two adult bats did not respond successfully to treatment.

Similar treatment will be relevant to poisoning by other anticoagulants, such as Pindone[1] and Brodifacoum[2].

[1] MSDS Pindone http://keyindustries.co.nz/Portals/0/PDFs/Pindone%20PR%20Pellets%20SDS_16.4.18.pdf
[2] MSDS Brodifacoum https://www.pestoff.co.nz/assets/sdsbrodif02.pdf

Cholecalciferol Poisoning

Cholecalciferol[1] is a semi-acute toxin that acts when metabolised to mobilise calcium from bones into the blood stream (Fairweather and Fisher 2018). This often results in mineralisation and blockage of blood vessels, with death probably occurring due to heart failure, along with renal failure and gastrointestinal haemorrhaging (Fairweather and Fisher 2018).

Fairweather and Fisher (2018) state that: "*There is effective treatment for cholecalciferol toxicosis. The prognosis is good for animals treated before tissue mineralisation occurs, but treatment of animals with severe or advanced signs of poisoning is difficult and prognosis is guarded.*"

Morrow (2001) provides details of treatment for Cholecalciferol poisoning[2]:

- Hydration with subcutaneous injection of fluids[3].
- 2 to 4 mg/kg furosemide given orally every eight hours[4].
- Do not use thiazide diuretics, because they are calcium-sparing.
- Administering prednisone at 1 to 2.2 mg/kg every 12 hours orally.
- Phosphate binders (aluminium hydroxide [Amphojel - Wyeth-Ayerst]; 30 to 90 mg/kg/day divided, given orally with meals) and a low-calcium, low-phosphorus diet are recommended to decrease dietary mineral absorption while a patient is being treated and monitored (generally four weeks).
- Treated animals should avoid sunlight.
- Consider using activated charcoal in symptomatic patients if the risk of aspiration is low.
- Furosemide and prednisone can be continued for one or two weeks after fluid therapy is discontinued.
- Monitor calcium concentrations daily for four days after stopping fluids, twice a week for two weeks after that, and then weekly for two weeks (Morrow 2001).

It is likely that most carers or vet clinics will be unable to care for a bat for the amount of time required for recovery, rehabilitation, and rebuilding of flight fitness, and euthanasia should be considered.

1 MSDS Cholecalciferol http://www.connovation.co.nz/vdb/document/73
2 http://www.aspcapro.org/sites/pro/files/n-toxbrief_1201.pdf
3 Morrow's (2001) suggestion of treating intravenously is likely to be difficult in bats.
4 Morrow's (2001) suggestion of treating intravenously is likely to be difficult in bats.

10.1.2 Pain alleviation

Pain alleviation is critical, as for all animals in care. Pain relief medication must be prescribed by a veterinarian. Potentially useful drugs and dose rates are addressed in Appendix 1.
Medication may be toxic to bats if they enter torpor and care should be taken to ensure that this does not happen (Miller 2016) by keeping bats at a suitable temperature: 30-32^{0}C (NSW WIRES Inc. 2018). Keeping bats at an appropriate temperature also assists in reducing metabolic stress.

Hirudoid® cream, Neotopic H and Flamazine cream/Flaminal hydro gel are useful for improving blood flow to the extremities of the wing membrane, which is critical for survival of the membrane.

Topical Hirudoid® cream should be used when the bat has bleeding injuries (NSW WIRES Inc. 2018). Topical medicines should be used sparingly, to avoid ingestion by the bat.

Aspirin® should not be used in the treatment of bats.

In relation to Aspirin® Bishop (2018, Pages 4-5) states:

> "*therapeutic concentrations are very close to toxic concentrations in most species. (Morton & Knottenbelt 1989) Compared to other NSAIDs* [Non-Steroidal Anti-inflammatory Drugs] *the analgesic properties of aspirin are also very weak. Aspirin has also been associated with irreversible cartilaginous destruction, irreversible platelet dysfunction, renal impairment and gastrointestinal bleeding and ulceration. (Fox.2010) The anti-clotting effects on platelets also increases the likelihood of catastrophic bleeds during surgeries if required post administration of Aspirin®. Considering the physiological state of* [most rescued bats], *(dehydration, heatstroke, shock), the benefits of Aspirin® use do not outweigh the short and long term risks of its use."*

The following advice is from Miller (2016) and therefore relates to bats from the United Kingdom and should be used with caution.

Please note that Prescription Only Medicines (POM) and Prescription Only Medicine - Veterinarian (POM-V) for animals can only be prescribed by veterinarians for animals **in their care.**

Anaesthesia

- General anaesthesia can be undertaken using the volatile agent isoflurane for both induction and maintenance. These are delivered through oxygen mixtures.
- injectable general anaesthetic agents are not advised.

Analgesia

- Meloxicam (e.g. Metacam Oral suspension). Contraindicated in dehydrated individuals.

Antibiotics

- There are no antibiotics specifically licensed for use in bats; however they have been used to good effect. The use of antibiotics should be very carefully considered and only used according to need.
- All antibiotics should be given orally.
- The small size of the bat and the potential for the bat to go into torpor should be taken into account.
- Doses should be calculated for body mass and should be given to bats while warm and active. These products could be toxic to bats in torpor because of their changed metabolism; therefore bats should be kept warm during and after treatment until all of the drug has been excreted.
- The table below provides information on antibiotics that have been used in UK bats:

Antibiotic Name	UK Brand Names
Amoxicillin/clavulanic acid	Clavamox drops Synulox palatable drops
Enrofloxacin	Baytril

Ectoparasiticides

- Small numbers of ectoparasites can be removed with a fine damp paintbrush.
- Heavy loads of ticks (*Argas vespertilionis*) can be treated with POM-V Frontline spray. Do not spray directly onto the bat, spray into a dish and use a fine paintbrush to apply to the nape of the neck or directly onto the ticks. This is available through vets.

It should be noted that a small number of ectoparasites is normal for New Zealand bat species.

The drug and associated dose rates currently used by Wildcare (Lyons and Wimberley 2018) and others are included as Appendix 1.

10.2 Short-term housing for intensive care

In the short-term, whilst bats are in intensive care, bats can be housed in incubators (or a humidifier) and placed in a sling or pouch attached to the side of an incubator or on its floor so that the bat can crawl or be placed inside if it is unable to hang (Plate 9). If an incubator is not available, then bats should be kept in a holding box that has grooves in its side or cloth attached to its side for the bats to crawl inside and hold onto (Appendix 2). If the bat is injured then additional heat, and possibly a humidity source, may be required. Note that if bats are seriously injured then it is best to place them in a sling so that they do not have to hang. If a heat pad is used, then there should be a heat gradient provided so that bats can move away from the heat[1].

When in intensive care, bats can be placed horizontally in order to manage swelling and other injuries, and to address the inability to hang if this is presenting (NSW WIRES Inc. 2018). Regular cleaning and turning of the bats is essential to avoid or minimise issues such as urine scald and pressure sores (NSW WIRES Inc. 2018).

Bat pups that are non-thermoregulating need to kept at temperatures of 32-38^{0}C with humidity of 75-90% (NSW WIRES Inc. 2018). They can be kept in pouches hung on the side of a 'humidicrib'.

Plate 9: Intensive care housing for bats. Hairless pups were held in this incubator and temperature and humidity were monitored. Bats were kept in slings or pouches attached to the sides of the incubator. Photograph: Debra Searchfield, Auckland Zoo.

[1] The pouch that the bat is in could be placed 2/3 on the heat pad so there is a heat gradient (NSW WIRES Inc. 2018).

Initially, juvenile and adult bats should be kept at temperatures of 30-34^{0}C and humidity of 50-70% (NSW WIRES Inc. 2018, R. Lyons, Wildcare, Pers. Comm., 27 May 2019) to avoid them entering torpor so that growth and healing is encouraged and medication is effective and less likely to become toxic[1]. It should be noted that Sedgeley *et al.* (2012) suggest that bats should be kept at temperatures of 25–28^{0}C in order to remain out of torpor. Consequently, appropriate temperatures are likely to be centred around 30 ^{0}C. Observations should be made of bats in care, and temperatures adjusted according if they appear to enter torpor. In the case of a long-tailed bat that was held over a long period for rehabilitation, a temperature of 25-26^{0}C was considered suitable later in its rehabilitation once it was stable, i.e., no longer medicated and injuries had healed. Room temperatures were then slowly reduced so that they matched ambient (outdoor) temperatures on the bat's predicted release date.

[1] Czenze *et al.* (2017) found that 91.5% of short-tailed bats entered torpor on a daily basis during summer, even when mean ambient temperatures were as high as 19.5^{0}C. Appropriate temperatures to help ensure that bats remain out of torpor are therefore substantially higher than 19.5^{0}C. This should be reviewed if further research takes place into the use of torpor by New Zealand bats.

10.3 Diet

When in emergency intensive care, bats may be fed using a syringe with a blended mix of warmed meal worms and water. Glucose should be used to supplement the diet of all bats held in care for at least the first three days that they are held, and this should continue until bats are no longer dehydrated and/or emaciated, or have infections (Lyons 2018). The blended food diet currently used by Wildcare for bats in intensive care, and for young pups, is included in full as Appendix 4 of this document (Lyons and Wimberley 2018).

In an emergency, bats may be fed tinned cat or dog food (Miller 2016). The pet food should be made into a paste with a small amount of water and fed to the bat on the end of a small, clean, paint brush or teaspoon (Miller 2016).

In the short-term, bats may be fed with juvenile meal worms, although these are nutritionally deficient (Miller 2016) and may contain insect growth inhibitors which have been suspected to be associated with bone density and development deficiencies in bats (Lyons 2018). Meal worms may be available from pet stores and can also be purchased on-line. Meal worms can be gut-loaded to increase their dietary value to bats. Gut-loading can take place by keeping meal worms, at room temperature for 24 hours, in a substrate made of the following:

- ½ cup Wombaroo Small Carnivore Mix®.
- ½ cup Missing Link® (or ground flax seed with ½ teaspoon of Soluvet vitamin supplement).
- ½ cup fresh wheat germ (NSW WIRES Inc. 2018).

Alternatively, an insect booster and fresh wheat germ can be used (Rachel Lyons, Wildcare, pers. comm., 27 May 2019).

Immediately prior to the feeding of meal worms to bats, sprinkle Missing Link® over the meal worms.

Bat pups will still require milk in their diet, and frequently. Bat pups should be fed on demand, when their stomachs are empty. The use of cows' milk-based formula for Australian bat care has been associated with bloat and metabolic bone disorder and goats' milk-based formula should be used (Lyons 2018). Absorption of milk should take place over 2-4 hours. If absorption does not occur over this period it could be because hydration and/or their temperature may not be sufficient to support absorption of food. Refer to Lyons and Wimberley (2018) for more information. Rachel Lyons, Wildcare, can be contacted directly to obtain up-to-date information (see Section 10) and for access to videos demonstrating feeding of bat pups. The milk replacement recipe currently used by Wildcare is included in full in Appendix 5 (Lyons and Wimberley 2018).

To ensure that overfeeding does not occur, food intake should be managed so that their stomach does not expand greater than the width of their rib cage (Rachel Lyons, Wildcare, pers. comm., 27 May 2019). This is because a number of bat species appear do not appear to have a response mechanism that tells them that they are full in a short enough period to stop them overfeeding (Rachel Lyons, Wildcare, pers. comm., 27 May

2019). One rehabilitating long-tailed bat, for example, ate a daily average of 23 mealworms, 8 wax moth larvae, and 7 ml of Wombaroo Insectivore Mix® as well as drinking water when held at Hamilton Zoo (Trudy Willetts, Hamilton Zoo, pers. Comm.).

In the longer term, Wombaroo Small Carnivore Mix® (dry or crumbled), and gut-loaded meal worms should be used (NSW WIRES Inc. 2018). When this has not been available, Wombaroo Insectivore Mix® has been successfully used to rehabilitate a long-tailed bat, when made into a slurry following company instructions.

Short-tailed bats held in captivity at Auckland Zoo were offered five grams of meal worms per animal every evening and a small amount of fruit or jam or honey water, in a compartmentalised dish on a stand. Leaf litter was replenished regularly in the planted enclosure and would likely have provided invertebrates. Moths and other invertebrates, such as small locusts or crickets, were provided on an ad hoc basis. Additional flowering trees were also moved in and out of the enclosure as available (Debra Searchfield, Auckland Zoo, pers. comm., 22 April 2019).

When short-tailed bats were kept in care at the Wellington Zoo, they ate a range of commercially-available fruit, including banana, apple, peach, feijoa, grapes, melon, avocado, and plums (Blanchard 1992; S. McQueen, pers. comm. in McCartney *et al.* 2007). They also consumed meal worms (larvae and adult), cerambycid beetles (*Prionoplus reticularis*), tree wētā (*Hemideina crassidens*), crickets (*Teleogryllus commodus*), and some nectars, particularly *Eucalyptus* (McCartney *et al.* 2007).

When providing invertebrates either directly or indirectly, via the provision of leaf litter, the exposure of bats to toxins via these invertebrates should be carefully considered. Toxins may include herbicides and pesticides that may have been consumed or otherwise absorbed by invertebrates. Toxins that may be lethal to bats may not necessarily kill or may not be particularly toxic to invertebrates. These toxins can be persistent and accumulative.

10.4 Teaching bats to feed

New Zealand bats are generally not used to feeding on stationary objects so need to be taught to feed in captivity. This can take a substantial amount of time and patience. There appear to be differences in the propensity of each species to be trained to feed themselves (C O'Donnell, Department of Conservation, 29 August 2019). Training lesser short-tailed bats appears to be relatively easy compared to long-tailed bats (C O'Donnell, Department of Conservation, 29 August 2019). For tinned pet food this can be as simple as placing the prepared food on the end of a clean paint brush or teaspoon and placing this gently against or into the bat's mouth.

Meal worms can be fed initially by decapitating the meal worm, and squeezing out the insides into the bat's mouth (Plate 10). Individual bats may learn to feed on decapitated meal worms left in a shallow dish in their enclosure. Live meal worms should not be left alone with young or weak bats, or those with open wounds due to the risk of the meal worms grazing on the bats (Miller 2016). Sedgeley (1995) found that an uninjured adult male long-tailed bat, which was held in captivity, ate up to twenty meal worms in one night.

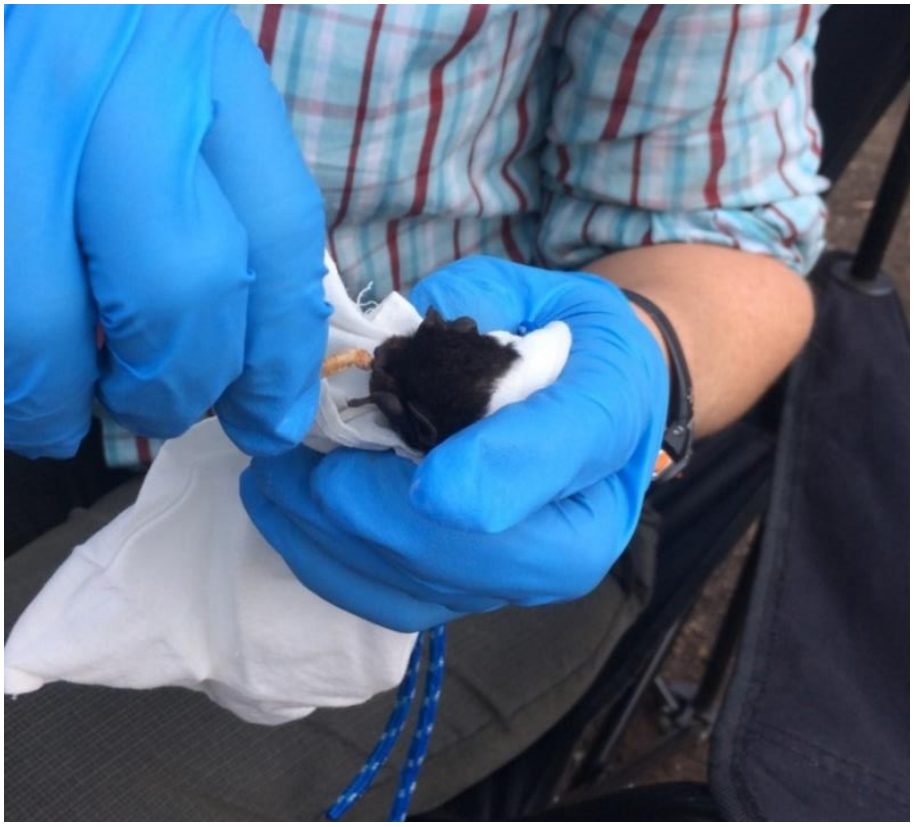

Plate 10: Decapitated meal worm being fed to an adult female *Chalinolobus gouldii*, a species in the same genus as the long-tailed bat. Photograph: K Borkin collection.

During the teaching phase, bats should be held in a pouch with their head down (their usual orientation when feeding).

Food and water should be provided in shallow dishes, as shown in Plate 11.

Plate 11: Young short-tailed bat pup, born and held at Auckland Zoo, drinking freely from a small dish. Photograph: Debra Searchfield, Auckland Zoo.

10.5 Longer term care

When bats are 'on the road to recovery' - i.e., out of intensive care and able to hang, feed, and toilet and groom themselves - they can be placed in a mesh terrarium with all sides covered in cotton sheets or polar fleece with a heat pad at one end (NSW WIRES Inc. 2018). Due to the likelihood of mite infestation with long-term care, it is suggested that roosting material is cleaned or replaced regularly with substances that are not toxic to bats.

Water should be provided in a dish, ideally with one attached to the side of the enclosure and one on the floor. Water containers must be shallow enough to minimise the risk of drowning and water must be changed daily (NSW WIRES Inc. 2018). Food can be also provided in a dish. Ideally food and water containers should be placed above the ground (Goudswaard *et al.* 1998) with space surrounding them so that bats are able to land and take off next to the containers.

Bats need to be fully fit when released so that they are able to fly well enough to capture sufficient food to survive. The use of an aviary adapted to hold bats is advisable. For wattled bats, such as the long-tailed bat, NSW WIRES Inc. (2018) suggests that an optimal flight space is at least 8 × 8 × 3 metres, although these bats are also able to fly in smaller spaces such as 4 × 4 × 3 metres[1]. If it is a smaller space then consider covering the walls with cotton sheets or polar fleece to avoid injuries to wing tips (NSW WIRES Inc. 2018). The use of large flight aviaries/cages may be important in improving survival post-release because this requires the bats to fly for longer periods and distances (Lyons and Wimberley 2018). Holding bats in small areas may result in a lack of fitness, with consequences. Four out of six short-tailed bats held by Wellington Zoo[2] had swollen wrist joints when they died (Heath *et al.* 1987). Heath *et al.* (1987) noted that this condition had been observed in other bat species and was associated with a lack of flying exercise. These bats had an area of 6 m^3 to fly about in, but Heath et al. (1987) considered that a larger enclosure that allowed prolonged flight times may have prevented the swelling.

Flight aviaries (flight centres) should include places for roosting, and opportunities for feeding. Providing multiple roost boxes, and several water and food containers, may reduce competition between individuals (Sedgeley *et al.* 2012). The flight aviary previously used by Auckland Zoo is shown in Plate 12 and the Holcim Flight Centre (NSW WIRES, New South Wales, Australia) in Plate 13. Live nocturnal insects should ideally have access to the area, to allow hunting practice. Pathways should be clearly delineated and kept clear of debris to avoid standing on bats (Sedgeley 1998). Ideally, free flight areas would have a double door entry/exit system and be partially roofed (Sedgeley 1998). Total roofing is not advised because of the need to maintain humidity and keep vegetation alive (Sedgeley 1998). Partial roofing should be designed to keep roost boxes and food containers dry (Sedgeley 1998). Meal worms drown quickly when inundated, and become unpalatable to bats (Sedgeley 1998).

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1 A free flight enclosure used to house lesser short-tailed bats in the Eglinton Valley is 10 m long ×5 m wide × 2 m high (Sedgeley *et al.* 2012).

2 That likely died of septicaemia in 1981. See Section 2.2 and Heath *et al.* (1987) and Goudswaard *et al.* (1998) for a more detailed description.

Short-tailed bats may burrow beneath objects, and this should be taken into account when designing any enclosure (Sedgeley and Anderson 2000).

Roost boxes constructed of rough sawn untreated wood can be placed within the free flight area (Sedgeley 1998). These should be placed sufficiently high in the enclosure so that bats are able to swoop down on exiting the box. Roost boxes similar to a Kent Bat Box design are used in Hamilton City by long-tailed bats, and may therefore be suitable for longer term captivity[1]. Insulating some boxes with closed cell foam may allow bats to choose roost boxes with a variety of temperature gradients (Sedgeley 1998).

Plate 12: Flight aviary previously used at Auckland Zoo to house short-tailed bats. Note the multiple roost boxes (wooden boxes) and vegetation to encourage invertebrates. Enclosure mesh is covered, to prevent injuries to wing tips. Photograph: Debra Searchfield, Auckland Zoo.

Plate 13: Holcim bat flight centre for improving flight fitness of insectivorous bats, WIRES, Goulburn New South Wales, Australia. Note that the mesh is covered with material to reduce the likelihood of injuries to wing tips. The tent has bat bags hanging inside it and provides medium-term accommodation for bats in care. Roost boxes can be attached to the ledge shown at the extent of the ladder. Photograph: K Borkin.

[1] Design originally by the Kent Bat Group, England. http://www.bnfc.org.uk/BNFC/Bat_boxes_files/Kent_Bat_Box_2010.pdf

11. RELEASE

In order to be released, a bat must be able to (Miller 2016) do the following:

- Fly for 10-15 minutes.
- Echolocate.
- Able to avoid and navigate objects.
- Feed.
- Groom itself.

Figuring out whether a bat is echolocating can be done using a hand-held bat detector set at a suitable frequency. These may be able to be borrowed from a local Department of Conservation office.

Pre-release flight training in a large cage is important for survival post-release. Wildcare suggest that bats should be flying well in a large aviary for four weeks prior to release (Lyons and Wimberley 2018).

A check by a veterinarian prior to release is important. Consultation with appropriate Department of Conservation staff regarding release is also required.

Ideally, bats should be released when warm, close to where they were found, in the early evening (after sunset whenever possible). Bats should be placed on a tree above head height or on a person's open hand and allowed to fly off independently. Do not throw a bat into the air as it may not be ready to fly and may to fall to the ground (Sedgeley *et al.* 2012). Do not shine a light directly at the bat.

If the original location of the bat is unknown, then it should be released near suitable habitat.

If a bat enters torpor when in the field it can be warmed by cupping it in your hands or by placing it in a cloth bag beneath clothing near warm skin, for body warmth (Sedgeley *et al.* 2012).

If release in this way is not possible, the bat may be placed inside a temporary artificial roost box or potentially within a known roost, and allowed to emerge after dark (Sedgeley *et al.* 2012).

After release, check to ensure that the bat has flown off successfully, taking particular care to check the ground at the site.

Bats born and raised in captivity without other bats of the same species may be unsuitable for release due to lack of contact, lack of detailed knowledge of any area, inability to forage on wild prey, and inexperience with suitable roost sites (Sedgeley *et al.* 2012) and due to the potential for introducing undetected diseases or other risks to the wild population. These risks should be weighed up carefully when options for care are being considered.

12. DEAD BATS

Bats that are either found dead or die in care should be placed in a refrigerator and the Department of Conservation must be notified as soon as practical. Necropsy may be required. Follow instructions from the Department of Conservation regarding storage and fate of the body. Transfer to a -80^0C freezer should be considered as soon as possible after necropsy as this could allow it to be used for research into, for example, topics such as genetics.

13. FURTHER INFORMATION

Links to useful sources of additional information are listed below:

- Collection of bats:
  http://www.irishwildlifematters.ie/animals/bat.html
- How to hold, handle, measure, identify species, age and sex, and release New Zealand bats (Department of Conservation, New Zealand):
  https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventory-monitoring/im-toolbox-bats/im-toolbox-bats-doc-best-practice-manual-of-conservation-techniques-for-bats.pdf
- Bat care for rehabilitators, Bat Conservation Trust, United Kingdom:
  http://alexvet.weebly.com/uploads/5/6/6/1/56610903/bat_care_guidelines.pdf
- Wellington Zoo, Auckland Zoo, and Wildbase Hospital (Massey University) have cared for short-tailed bats and may be able to provide advice.
- The following New Zealand-based vets may be able to offer advice: Brett Gartrell, Wildbase: B.Gartrell@massey.ac.nz , Baukje Lenting, Wellington Zoo: baukje.lenting@wellingtonzoo.com Lisa Argilla, Wildlife Hospital Dunedin: L.S.Argilla@protectbirds.com , Kate McInnes, Department of Conservation KMcInnes@doc.govt.nz
- The following Australian-based veterinarian may be able to offer advice: Tania Bishop, Australia Zoo, taniab@wildlifewarriors.org.au
- The following Australian-based bat care expert may be able to offer advice, and has a number of videos available demonstrating techniques: Rachel Lyons, Wildcare, Rachel@wildcare.org.au
- The draft Department of Conservation Duty Officer guide for staff who may need to deal with reports of sick or injured bats is included as Appendix 2 of this document.
- Vegetation removal protocols are frequently used during land development projects with the aim of avoiding or minimising harm to bats wherever they occur. An example of clauses related to the care of any bats that are found during these operations has been drafted and is included as Appendix 3 of this document.
- The blended food diet currently used by Wildcare, Australia, is provided as Appendix 4 of this document (from Lyons and Wimberley 2018, Page 98). Rachel Lyons can be contacted by email in order to ensure that the diet is current as the recipe is a work in progress (Rachel@wildcare.org.nz ; R. Lyons, Wildcare, pers. comm., 27 May 2019).
- The Milk replacement currently used by Wildcare, Australia, is included as Appendix 5 of this document (from Lyons and Wimberley 2018, Page 98). Rachel Lyons can be contacted by email in order to ensure that the diet is currently recommended as the recipe is a work in progress (Rachel@wildcare.org.nz ; R. Lyons, Wildcare, pers. comm., 27 May 2019).

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DRUG FORMULARY FOR BATS

This information is provided for VETERINARY USE ONLY. The drugs and products listed are for routine treatment only- culture and sensitivity results would indicate the most appropriate drug treatment regime. Veterinary discretion is required.
NOTE: All use of veterinary medicines for bats is "off label".

Abbreviations in the table: PO oral, SC subcutaneous, IM intramuscular, IV intravenous, SID once per day, BID twice per day, TID three times day, QID four times a day, EOD every second day, IU international units, ug micrograms, mg milligrams, kg kilograms, ml millilitres
Ref = reference to source of drug information, Txt = this drug is mentioned in the document text in Section 10 Initial Care: Treatment and Housing.

Product Name	Active Ingredient(s)	Dose Rate	Notes	Ref	Txt
Anaesthetics					
Isoflurane®	Isoflurane	5% for induction and 2-3% for maintenance with oxygen flow rate of 1-2 litres per minute	Using a short Isoflurane general anaesthesia is very useful when handling bats for treatment.	1	Yes
Fluids					
Hartmann's solution	Sodium chloride, sodium lactate, potassium chloride, calcium chloride	Mix 50:50 with 2.5% glucose solution. Dose at 10% body weight	"Giving sub-cutaneous fluids to a rescued bat is never the wrong thing to do" (Tania Bishop, Australia Zoo, pers. comm.).	2	Yes
Glucose 5%	5% glucose sterile fluids	As above	Used in combination with saline 50:50 mix to make a 2.5% glucose solution.	2	Yes
Saline	0.9% sodium chloride	As above	Used in combination with saline 50:50 mix to make a 2.5% glucose solution.	2	Yes
Analgesics					
Metacam ®	Meloxicam	0.2mg/kg injectable or oral	Ensure good hydration.	2	Yes
Metacam ®	Meloxicam	0.2mg/kg PO, IM or SC SID	Oral doses should be diluted with Lactulose. Not to be used until bat is hydrated.	1	Yes
Methone ®	Methadone hydrochloride	0.3-0.5 mg/kg severe trauma/fractures etc. 0.1-0.2 mg/kg for severely stressed animals or severe soft tissue injury. SC or IM Q4-6 hourly.	Use with caution as can depress cardiovascular system.	1	
Temgesic ®	Buprenorphine hydrochloride	0.01mg/kg SC or IM Q8-12 hourly	Preferred over Methadone.	1	
Painstop ® For Children Day-Time Pain Reliever Syrup	Paracetamol 24mg/ml, Codeine 1mg/ml	15mg/kg of Paracetamol component PO Q6-8 hourly.		1	
Panadol Baby Drops ®	Paracetamol 100mg/ml	15mg/kg PO Q6 hourly.		1	

Product Name	Active Ingredient(s)	Dose Rate	Notes	Ref	Txt
Topical Treatments					
Traumeel®	Water, Ethanol, Carbopol, Sodium hydroxide, Homeopathic ingredients	Use sparingly	For bruising with no skin ruptures.	3	Yes
Betadine®	Povidone-Iodine	Use diluted	For wound cleaning.	8	Yes
Chlorhexidine	Chlorhexidine	Use diluted	For wound cleaning.	8	Yes
EpiOtic® Skin & Ear Cleanser	Lactic acid 25mg/ml, Salicylic acid 1.1mg/ml	Topical use	Membrane damage debridement.	4	Yes
SoloSite Gel®	Wound gel	Topical use	For treatment of exposed bone/tendon.	4	Yes
Flalminol Hydro® Gel	Wound gel	Topical use	For treatment of exposed bone/tendon.	4	Yes
Comfeel® Dressing	Wound dressing	Topical use	For treatment of exposed bone/tendon.	4	Yes
DuoDERM thin® Dressing	Wound dressing	Topical use	For treatment of exposed bone/tendon.	4	Yes
Tegaderm® Dressing	Wound dressing	Wound dressing	Membrane damage wound dressing.	4	Yes
Ungvita® Vitamin A Ointment	Vitamin A	Topical use	Membrane damage scar management.	4	Yes
Hirudoid cream®	Heparinoid bovine 3mg/g	Topical use	Membrane damage topical treatment.	4	Yes
Neotopic H®	Neomycin 5mg, Hydrocortisone 5mg, Lignocaine HCl 5mg per 50g	Topical use	Membrane damage topical treatment.	4	Yes
Neocort®	20mg/g Lignocaine, 5mg/g Neomycin, 5mg/g Hydrocortisone	Topical use	Membrane damage topical treatment.	4	Yes
Flamazine®	Silver sulfadiazine 1%	Topical use	Membrane damage topical treatment.	8	Yes
Antibiotics/Antifungals					
Baytril®	Enrofloxacin	5mg/kg SC SID	Bite or puncture wound infection.	8	Yes
-	Enrofloxacin	50mg/ml injectable 1:5 diluted with saline, nebulised for 20 minutes twice daily	Pneumonia.	8	Yes
Baytril®	Enrofloxacin	5mg/kg PO BID or SC/IM SID		1	Yes
-	Amoxicillin/Clavulanic acid	12.5-20 mg/kg SID injected, BID oral	Exposed bone/tendon.	8	Yes
Clavulox® liquid	Amoxicillin 140mg/ml, Clavulanic acid 35mg/ml	24mg/kg PO BID or SC/IM SID		1	Yes
-	Gentamicin	1:5 diluted with saline, nebulised for 20 minutes twice daily	Pneumonia.	8	Yes
-	Nystatin	50000 IU BID PO	May be associated with bloat.	2	Yes
Betamox®	Amoxicillin	20mg/kg SC or IM BID		1	
Antirobe®	Clindamycin	11mg/kg PO BID	For bone and anerobic infection or protozoal infections (rare).	1	
Flagyl®	Metronidazole	15mg/kg PO, SC or IV BID	Used in combination with Clavulox® as a preferred alternative to Antirobe. For severe sepsis, bone and anerobic or protozoal infections (rare).	1	

Product Name	Active Ingredient(s)	Dose Rate	Notes	Ref	Txt
Other					
Infacol® Colic Relief Drops	Simeticone		Bloat treatment.	4	Yes
Salbutamol	Salbutamol	2.5mg nebule 1:1 with saline	Aids nebulisation for pneumonia.	8	Yes
Solucortef®	Hydrocortisone sodium succinate	50mg/ml, 5mg/kg SC SID	Pneumonia.	8	Yes
Solucortef®	Hydrocortisone sodium succinate	5mg/kg IV or SC, usually single dose		1	Yes
Redipred®	Prednisolone sodium phosphate	5mg/mL, 0.5-1 mg/kg PO BID × 2, SID × 2, EOD		8	Yes
Redipred®	Prednisolone sodium phosphate	0.5mg/kg PO BID daily, then wean down to SID, then every second night		1	Yes
Konakion®	Vitamin K	10mg/kg SC BID		5	Yes
Compounded Vitamin K solution	Vitamin K	10mg/kg PO BID × 34 days		5	Yes
Furosemide	Furosemide	2-4mg PO TID	Treatment of cholecalciferol poisoning.	6	Yes
	prednisone	1-2.2mg/kg PO BID	Treatment of cholecalciferol poisoning.	6	Yes
Amphojel®	phosphate binders	30-90mg/kg PO divided with meals	Treatment of cholecalciferol poisoning.	6	Yes
Illeum Selvite E®	Vitamin E 45.6mg/ml and Selenium 2.5mg/ml	1ml/30kg IM SID x 3 days		1	
Zantac®	Ranitidine	1mg/kg IV or SC BID		1	
Carafate®	Sucrulfate	Smallest amount possible of a ground tablet		1	
Antiparasitic/ Anthelmintics					
Frontline® spray	Fipronil	Spray into a dish and use a fine paintbrush to apply to the nape of the neck or directly onto the ticks.	For treatment of ticks.	7	Yes
Ivomec®	Ivermectin	0.2mg/kg SC or PO single dose		1	
Vetdectin® (and other brands)	Moxidectin	0.2mg/kg SC or PO single dose		1	

[1] Adopted from Exotic Animal Formulary (3rd Edition) (Carpenter, JW - Saunders 2004) or advised by Dr Claude Lacasse (Australia Zoo Wildlife Hospital, Queensland) or Dr Tania Bishop (Dayboro Vet Clinic/Australia Zoo Wildlife Hospital, Queensland). [2] Dr Tania Bishop (Dayboro Vet Clinic/Australia Zoo Wildlife Hospital, Queensland). [3] Lyons & Wimberley 2014. [4] NSW WIRES Inc. 2018. [5] Dennis and Gartrell 2015. [6] Morrow 2001. [7] Miller 2016 [8]Contributor not stated in text.

DEPARTMENT OF CONSERVATION
DRAFT GUIDELINES FOR SICK OR INJURED BATS

Source: Ward J. 2019: Department of Conservation Draft Guidelines for Duty Officers who may have to deal with sick or injured bats: Live Bats - Duty Officer Guide. Department of Conservation, Wellington, New Zealand. Provided by Kate McInnes (Department of Conservation, 1 April 2019).

Area	Guidelines	Further Information/ Resources
Identification	Bats should be scanned for a microchip (PIT tag) and the number recorded if present. PIT tags must only be inserted by trained personnel.	Best Practice Manual of conservation techniques for bats (DOCDM-131465.) https://doccm.doc.govt.nz/wcc/faces/wccdoc?dDocName=DOCDM-131465 Sedgeley J., O'Donnell C., Lyall J., Edmonds H., Simpson W., Carpenter J., Hoare J., and McInnes K. 2012: DOC best practice manual of conservation techniques for bats. Department of Conservation, New Zealand. *DOCDM-131465.* https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventory-monitoring/im-toolbox-bats/im-toolbox-bats-doc-best-practice-manual-of-conservation-techniques-for-bats.pdf
Handling	Handling time of any bat should be minimised. NZ bat species may bite. All bats which appear to be sick should be handled with gloves, such as thin gardening or cloth gloves. Any person(s) regularly handling bats should obtain rabies vaccinations as a precautionary measure	
Temperature	Bats should be provided with warmth of approx. 25 degrees Celsius and 50-60% humidity. In very hot conditions it may be necessary to provide extra humidity by placing a dampened paper on the floor on the box or moisten the bottom of the holding bag.	
Housing (short-term)	Bats may be kept for a maximum of one night (24 hours) in cloth bags, somewhere quiet with low light with good humidity. Max of two bats per bag. If held for more than one night, it must be kept in a holding box. Boxes must be well ventilated, dark and either have grooves in the walls or a suitable material such as shade cloth fixed to the walls to allow bats to grip while roosting.	
Transport containment	Wooden box as above. Bird transfer boxes can be modified for bat transport.	
Nutrition and Hydration	The bat must be offered food and water if held for more than a couple of hours. Meal worms can be a short-term food for either bat species. Short-tailed bats should eat these readily, long-tailed bats normally eat moths and flying insects so may require hand-feeding. Record amounts eaten and the weight of the bat daily.	
Deceased bats	Chilled to four degrees Celsius (not frozen) and delivered to the local DOC office as soon as possible. Bodies must be sent for necropsy (post-mortem) via the Massey University pathology service	
Torpor	Note that at cooler temperatures bats will become torpid and unwilling to fly or move. Warm up bats by cupping in your hands, warmed room, or in the cloth bag beneath some clothing for body warmth.	

APPENDIX 3

VEGETATION REMOVAL PROTOCOLS

Vegetation removal protocols are frequently required when bats are known to present in the vicinity of land development projects. The following provisions may be useful for the care of any bats found during vegetation clearance:

(a) Any bats found during felling/vegetation removal either trapped within a roost or on the ground will require handling and/or short-term retention (e.g. dead or possibly injured bats) and should be inspected by a suitably qualified bat ecologist for obvious injuries. There must be bags and/or other equipment at the felling site, ready to hold any captured bats. All bats that are found post-felling must be taken to a vet for triage or further care. Any bats found on the ground must be kept for observation for three days, and they should not be allowed to enter torpor during this time, so that any injuries/severe bruising are able to be observed[1]. Meal worms should be available in case of bats being needed to be held for observation. The vet must be prepared to give the bat subcutaneous fluids because of the likelihood of bats becoming dehydrated. Vets should be provided with Borkin (2019) Initial veterinary care for New Zealand Bats. *Wildland Consultants Ltd Contract Report No. 4984*. Prepared for Department of Conservation, Wildlife Society of the New Zealand Veterinary Association, and New Zealand Transport Agency.

(b) Injured bats should be immediately taken to a vet for assessment. Bats should be placed within a cotton or similar material bag in a cool, quiet, dry location during transport. Bats which have obvious injuries that are assessed as being serious, or likely to reduce their ability to function independently long-term, should be assessed promptly using criteria for euthanasia. If the vet has no experience with bat care then they should contact a bat specialist. The bat specialist should be contacted prior to felling/vegetation removal taking place, so that they are aware of the timing of operations.

(c) The Department of Conservation (nearest District Office, or office that has been involved in/is aware of the process, or Department of Conservation Hotline if after hours[2]) should be contacted no longer than two hours after a potentially injured or dead bat is found.

(d) Any bat that is found dead or must be euthanised is to be returned to the local Department of Conservation Office.

(e) Department of Conservation advice should be sought with regards to the rehabilitation requirements of any injured bats. For example, legislative requirements will need to be considered.

(f) Any rehabilitated bat (that is able to be released) should be released in the same general location in which it was found. Such releases should occur after works at the release site have been completed.

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1 This means that the bat must be kept at temperatures between 30-32^{0}C with 50-70% humidity so that they do not enter torpor (although pups may need higher temperatures, NSW WIRES Inc. 2018). Torpor is a reduced metabolic state. If bat enter torpor their injuries, such as severe bruising, may not either develop in time to be assessed prior to scheduled release, medication may not be effective and/or they may not heal adequately (NSW WIRES Inc. 2018).

2 After Hours - Phone: 0800 DOCHOTline (0800 362 468).

BLENDED FOOD DIET

Source: reproduced with permission from Lyons and Wimberley (2018, Page 98).

Blended Food Diet Recipe

- 1.5 cups frozen mealworms (that have been prepared as per Appendix 3)
- ½ cup cold water
- 2 teaspoons of Missing Link®
- 1/8 teaspoon of Soluvet®) vitamin powder
- ½ teaspoon of Liquid Oral Care® (when feeding to Molossidae species in particular)
- ½ teaspoon of Megaderm® Supplement
- 1 scoop S26 Soy Powder or equivalent soy brand

On high speed in a glass blender mix ½ cup of cold water and gradually add the frozen mealworms and blend until it is the consistency of honey. Make sure the mixture remains cool as it can spoil if overheated. Add the remaining ingredients, blend quickly and store immediately in ice cube trays within a snap locked bag in the freezer. The frozen food can be kept for up to 30 days. When needed pop out a frozen cube and allow it to defrost in the fridge. Thawed mixture can remain in fridge for 2 days for use. Do not refreeze once defrosted.

Makes 2 ice-cube trays – feeding approximately 6 small bats per cube per night.
3 teaspoons of Missing Link® instead of 2 can be used if Megaderm® cannot be sourced.

Needs to be hand-fed to bats – do NOT leave in enclosure for self feeding – refer pg 69.

MILK REPLACEMENT FOR BAT PUPS

Source: reproduced with permission from Lyons and Wimberley (2018, Page 98).

Note – we are continually improving and updating our recipes as we perfect them – stay in touch on the 'Queensland Microbat Rehabilitation Forum' on Facebook for the latest.

Milk Replacement Diet A – Milk for Most Bat Pups

- 100mls fresh goats milk or same volume reconstituted powdered goats milk
- 1.5 scoops of S26 Soy Powder (or equivalent Soy Milk Powder)
- 2 mls Megaderm® Supplement
- 2 level tsp (4.3g) dried egg white powder (Egg Albumin) or white of 1 medium egg (which equates to 3.5g of protein approximately)
- ¼ teaspoon of Human Paediatric Pro-biotic Powder or Protexin®

Store in refrigerator immediately and discard after 24hrs.

ADVICE FOR FIRST RESPONDERS

This advice is provided for the first people who are made aware of a bat that could be injured. **Any bat that has been come across randomly (i.e. is unlikely to be injured) and appears sick, lethargic, or particularly aggressive should be handled only with extreme care, and always with gloves that will withstand a bite. This is because the bat may have an undiagnosed disease or have been poisoned, and the handler must protect themselves as a priority.**

If a bat is found in any of the following circumstances then it must be checked by a veterinarian and is likely to need care:

- On the ground during the day.
- Seen being attacked by another animal, such as a cat.
- In a tree that has been felled.
- It is likely that an incident has taken place, resulting in an injury to the bat.
- It was trapped or caught in something.
- There are obvious injuries.
- It is unresponsive or unconscious. Please note that bats do go into torpor - a reduced metabolic state - particularly if the weather is cold. Bats still breathe when in torpor, although at very slow rates (Morris *et al.* 1994). Bats in torpor can be mistakenly identified as dead. To find out more about torpor and how to rouse bats from it, scroll to the end of this appendix.
- Note that if the bat is inside a building it may just need assistance to escape (bats are known to use attics as roosts overseas and have been found in a building in New Zealand, Daniel and Williams 1984). If mobile, open up all windows and doors and turn off lights, so that the bat has the opportunity to fly outside by itself. If this is not successful, wait until the bat has landed then quickly place a cloth over it, carefully scoop it up and put it in a box that can be closed securely. Place the box outside, away from domestic animals and people, and let the bat emerge from the box in its own time. Do not swipe at the bat with a net as this may result in injury. If it is possible that the bat has been in the building for some time, i.e. several days or nights, then they should be checked by a vet for dehydration and other injuries.

Handling and Collection

Ideally, the bat should be placed in a cloth bag in a dark, quiet place at ambient (or slightly warmer) temperature and taken to a veterinarian for assessment as soon as possible[1]. A maximum of two bats should be kept in one bag (Appendix 2).

If you do not wish to handle the bat, and it is on the ground, place a cardboard box over it for protection, exclude domestic animals such as cats and dogs from the vicinity, and contact the Department of Conservation for advice/assistance on 0800 DOCHOT (0800 362 468)[2].

To avoid being bitten by the bat, you can wear gloves or use a small towel to scoop up the bat.

When handling the bat, care must be taken to not strain its wings, forearms, or flight muscles (Sedgeley *et al.* 2012). Handling should be kept to a minimum, to minimise stress.

Transport

- The bag must be secured during travel.
- Time spent transporting the bat should be kept to a minimum.
- Avoid diversions (e.g. don't go to the supermarket!).
- Keep the vehicle interior quiet (don't play loud music or talk loudly).
- Drive smoothly and carefully.
- Ventilate the car adequately as temperatures climb quickly in cars on hot days.
- Label the container/bag with "Live Bat".
- Let someone know that you are transporting a bat, in case of an accident (NSW WIRES Inc. 2018).

[1] The following was prepared for New Zealand forestry crews that are unlikely to have spare cotton bags handy: *"...put it in a cool, quiet, dark place, preferably in a cotton bag. If you don't have a cotton bag, then you might be able to tie up an old t-shirt and pop the bat into it. Wet the corner of the bag by dipping it into some water, and then hang the bag in a cool, quiet, dark place. Heat makes bats more active and burns through their energy quickly. Wetting the corner of the bag gives them water to drink."* (Borkin 2018). This recommendation differs slightly from that provided by Wildcare (R. Lyons, Wildcare, pers. comm., 27 May 2019), i.e. that ambient or slightly warmed temperature is best so that bats do not enter torpor.

[2] Advice provided for Department of Conservation Duty Officers is set out in Appendix 2 of Borkin (2019) Initial veterinary care for New Zealand Bats. *Wildland Consultants Ltd report number 4984*; Prepared for Department of Conservation, Wildlife Society of the NZ Veterinary Association, and NZ Transport Agency.

Record the History

Recording of a detailed history is critical to help understand what injuries, if any, the bat may have. A good way to compile a history is to answer the following questions:

- What time of day and date was it found?
- Who found the bat?
- Where was it found?
- What was it doing when found?
- What species is it, if known?
- What is its age (does it have hair?) and sex (male bats have an obvious penis)?
- Were other bats present?
- What happened/had just happened when it was found?
- If there has been a delay between the bat entering care and when it was found, what has happened over that time and where has it been previously?
- Has it had any treatment?
- Is it demonstrating any abnormalities, e.g. obvious broken bones, vocalisation, wing tears, puncture wounds?

Contact the Department of Conservation on 0800 DOCHOT (0800 362 468) to find out where to take the bat.

Is the bat in torpor?

Long-tailed bats go into torpor when they lower their body temperature, and metabolism, to save energy. In the summer this is largely 'light torpor', but the colder the temperature, the deeper it gets. At its extreme, their body temperatures are likely to go close to 0˚C, and they might only take a breath every couple of minutes. This means that bats can be in torpor and mistakenly identified as being dead.

If bats are disturbed when in partial torpor, they often extend their wings and tail until they are fully rigid, bare their teeth and utter a squeaking sound – this is a defense response. Even then their body temperatures are still very low, and they may arouse slowly over 15-30 minutes. Bats may be aroused from torpor by placing them in a warm, but not hot, safe location and checking on them regularly.

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