Guideline

Wildlife (Animals)

Flying-fox heat stress guideline

This is a non-statutory guideline aimed at providing roost site landowners/managers and wildlife carers information to aid in developing heat resilient flying-fox roosts and to prepare for, respond and recover from heat stress events.

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ABN 46 640 294 485

Queensland Government

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Acknowledgements

The department would like to acknowledge all stakeholders involved in the development of this guideline and thank them for their contributions.

Dr Tania Bishop was engaged by the department to develop this guideline. Dr Bishop would like to acknowledge:

- Rachel Lyons, Tim Pearson, and David Zammit for their input in those sections relating to their respective areas of expertise
- the work of Lee-Anne Veage from Logan City Council contributed to facilitate the initial workshop to brainstorm issues and create valuable connections between Local Government Association of Queensland (LGAQ) personnel with wildlife carers from different regions
- members of Wildlife Health Australia and everyone who reviewed draft material
- the tireless carers that respond to the heat events with such compassion and energy.

1 Purpose

The purpose of this flying-fox heat stress guideline (guideline) is to provide a framework for roost site enhancement, readiness, response, and recovery of flying-foxes during heat events. This guideline is designed for veterinary professionals and stakeholders involved with flying-fox heat stress HSE, and for people with varying levels of technical and local knowledge.

It aims to provide information about heat stress events and provide practical actions aimed at reducing death and suffering of flying-foxes before, during and after a heat stress event.

While this document is primarily intended for land managers, wildlife carers and veterinarians, it may also provide useful information for others interested in flying-fox conservation and flying-fox roost management.

2 Background

Four main species of flying-fox occur in Queensland: the black flying-fox (*Pteropus alecto*), grey-headed flying-fox (*P. poliocephalus*), little red flying-fox (*P. scapulatus*) and spectacled flying-fox (*P. conspicillatus*). Flying-fox populations can be affected by mass dying events generally caused by natural disasters such as fire, cyclone, food shortages and heat stress events. There is evidence of heat stress events causing flying-fox die-off in Australia from as far back as the eighteenth century, however, most observed events have occurred since 1994. It is predicted that heat stress events will rise in intensity and frequency due to the progression of climate change, and increased impacts of expanding urban heat islands.

Observations of past heat stress events indicate that flying-foxes begin to suffer from heat stress when the ambient air temperature exceeds 38°C, with fatalities occurring when the temperature exceeds 42°C. This is due to the reversing of the heat gradient (i.e. the flying-fox cannot cool down through radiative heat loss from its body as the ambient temperature is greater than its own body temperature). In Queensland, this usually occurs in the warmer months of November through to February. Heat stress fatalities most commonly occur during consecutive days with ambient temperatures above 40ºC.

Research suggests that extreme heat events affect black headed and spectacled flying-foxes more, with higher rates of mortality seen than in little red and grey headed flying-foxes.

Heat event impacts are also age and sex-specific with lactating females and juveniles at most risk.

2.1 The legislative framework and supporting information

This guideline is non-statutory. It provides information about management options that are consistent with the legislative framework and informs decision making about response to flying-fox heat stress events.

The *Nature Conservation Act 1992* is the primary legislation that regulates what management actions may, and may not, be undertaken at, or near, a flying-fox roost in Queensland. In some circumstances, other legislation may also apply, such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and council local laws.

3 Flying-fox biology and behaviour

An understanding of flying-fox biology and behaviour (‘normal’ vs ‘abnormal’) is imperative to mounting an effective and safe response to flying-fox heat events. Flying-foxes lack sweat glands which are used in other animals for cooling the skin surface and reducing body temperature. Flying-foxes can also dehydrate easily. Animals showing signs of heat stress and heat stroke may exhibit the following behaviours:

- **Wing fanning** – this is normal cooling behaviour, however, may be an early warning sign of minor heat stress depending on the ambient temperature and humidity.

- **Clustering** – flying-foxes may move further down roost trees into the middle-storey vegetation in search of cooler microclimates and cluster together in those areas.
- **Clumping** – flying-foxes will roost on top of one another on the shaded side of trees, in the understorey and even on the ground, in an attempt to stay in the coolest locations.
- **Evaporative cooling –** flying-foxes pant and lick their wrists to promote evaporative cooling as ambient temperature continues to rise and as clumping in cooler microclimates and wing fanning fails to lower their core body temperatures.

Note: Refer to section 1 'Behavioural Monitoring' of the *Technical appendices – Flying-fox heat stress guideline* for detailed information on what to look for in behavioural monitoring.

4 Importance of temperature and humidity

Considering humidity levels before determining a heat stress event response is critical.

When the air temperature within a roost reaches 40°C, the ambient temperature has exceeded the flying-foxes body temperature of 38°C. This results in the animals being unable to reduce their core body temperature via wing fanning. During periods of elevated humidity, flying-foxes are surrounded by a cloud of water vapour which inhibits the evaporative cooling process. As flying-foxes continue to fan and lick themselves, the heat produced by the energy of fanning their wings, coupled with the rising ambient temperature, can rapidly lead to heat stroke and deaths under these circumstances.

At lower humidity levels, flying-foxes tend to survive for longer periods, even at higher temperatures, as they can continue to effectively use the promotion of radiant heat loss, such as by wing fanning, to cool themselves.

It is therefore critically important to differentiate between a high humidity heat event of above 70% humidity versus a lower humidity heat event of under 70%.

In both cases, caution needs to be exercised when considering a response, as disturbing flying-foxes during a heat stress event when they are approaching their tolerance limits can lead to increased mortalities.

5 Roost monitoring

It is imperative to be able to recognise abnormal flying-fox behaviours at a roost site when they occur as this will quicken and aid the decision-making process during a heat stress event. Regular roost monitoring helps to build a better understanding of a range of flying-fox behaviours and is a recommended course of action for landowners of roost sites.

Continuous monitoring of roost sites in the lead-up to (when the ambient air temperature is approaching 38°C), and during heat stress events and after heat stress events will enable local governments and the community to better prepare for heat stress events in their areas.

Figure 1: Flying-foxes sheltering from the heat on a 40-degree day under a dense canopy in Bellingen Island camp, NSW – Photo courtesy of Tim Pearson

6 Planning for heat stress events

A key component of planning for a heat stress event at a roost site is to try and predict when the roost site will be affected. This allows for preparations to be made ahead of time, enabling a quick response during the heat stress event itself.

Sections 6.1 to 6.6 of this guideline outline the tools that are available to help monitor flying-fox roost temperature, humidity, and potential heat stress events.

6.1 Flying-fox Heat Stress Forecaster

The flying-fox heat stress forecaster was developed by Western Sydney University and The University of Melbourne. It uses weather data from the Bureau of Meteorology and flying-fox roost data from the National Flying-fox Monitoring Program. This forecaster predicts the roost locations where flying-foxes are likely to experience extreme heat and potential die-offs up to 72 hours in advance. It is available at: https://www.animalecologylab.org – search: Flying-fox heat stress forecaster.

6.2 Interactive Flying-Fox Web Viewer

The interactive flying-fox web viewer was developed by the Australian Government and presents roost census data collected via the National Flying-fox Monitoring Program. It shows the occurrence of the major flying-fox species on the eastern coast of Australia and allows users to analyse flying-fox roosts and the numbers of each

species counted in them over time. The viewer is available at: https://www.dcceew.gov.au – search: Interactive flying-fox web viewer.

6.3 Weather forecasts

Weather forecast services are available from agencies such as the Bureau of Meteorology and Weatherzone. It should be noted that temperatures within a flying-fox roost can differ greatly from the outside temperature reported or predicted by weather forecasts, and it is important to gather temperature and humidity readings from inside the microclimate of a roost when weather forecasts predict continuous days with temperatures at or above 38°C.

6.4 Data loggers

The use of well-positioned data loggers (located 1.2m off the ground and away from trees) provides a more accurate reading of the actual temperature and humidity within a roost site than weather forecasts. Real-time viewing of temperature and humidity readings gives the responders the ability to monitor roost conditions remotely and make further heat stress decisions depending on the data. There are now several temperature and humidity data loggers available commercially.

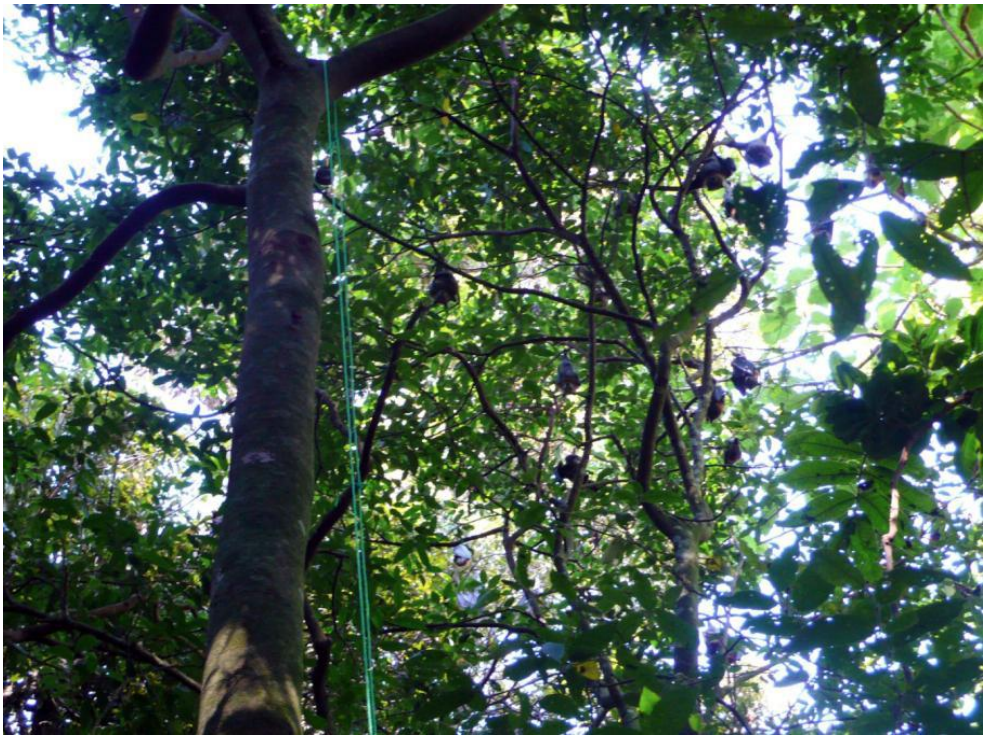


Figure 2: Kestrel Drop D2 datalogger attached to a rope over a tree branch in Bellingen Island flying-fox camp, NSW – Photo courtesy of Tim Pearson

6.5 Remote cameras

The use of remote video cameras at roosts is an efficient way to monitor flying-fox behaviour remotely.

6.6 Wildlife carers

Having the ability to contact and rely upon persons who are trained in flying-fox triage and trauma care, and vaccinated against Australian Bat Lyssavirus (ABLV), will afford the best chance of mitigating the effects of a heat stress event on flying-foxes. It is recommended that the owners or managers of a roost site collaborate with local wildlife carers trained in flying-fox rehabilitation to help plan for and manage heat stress events.

7 Heat stress behaviours and biology

Figure 3: Summary stages of heat stress impacts on flying-foxes

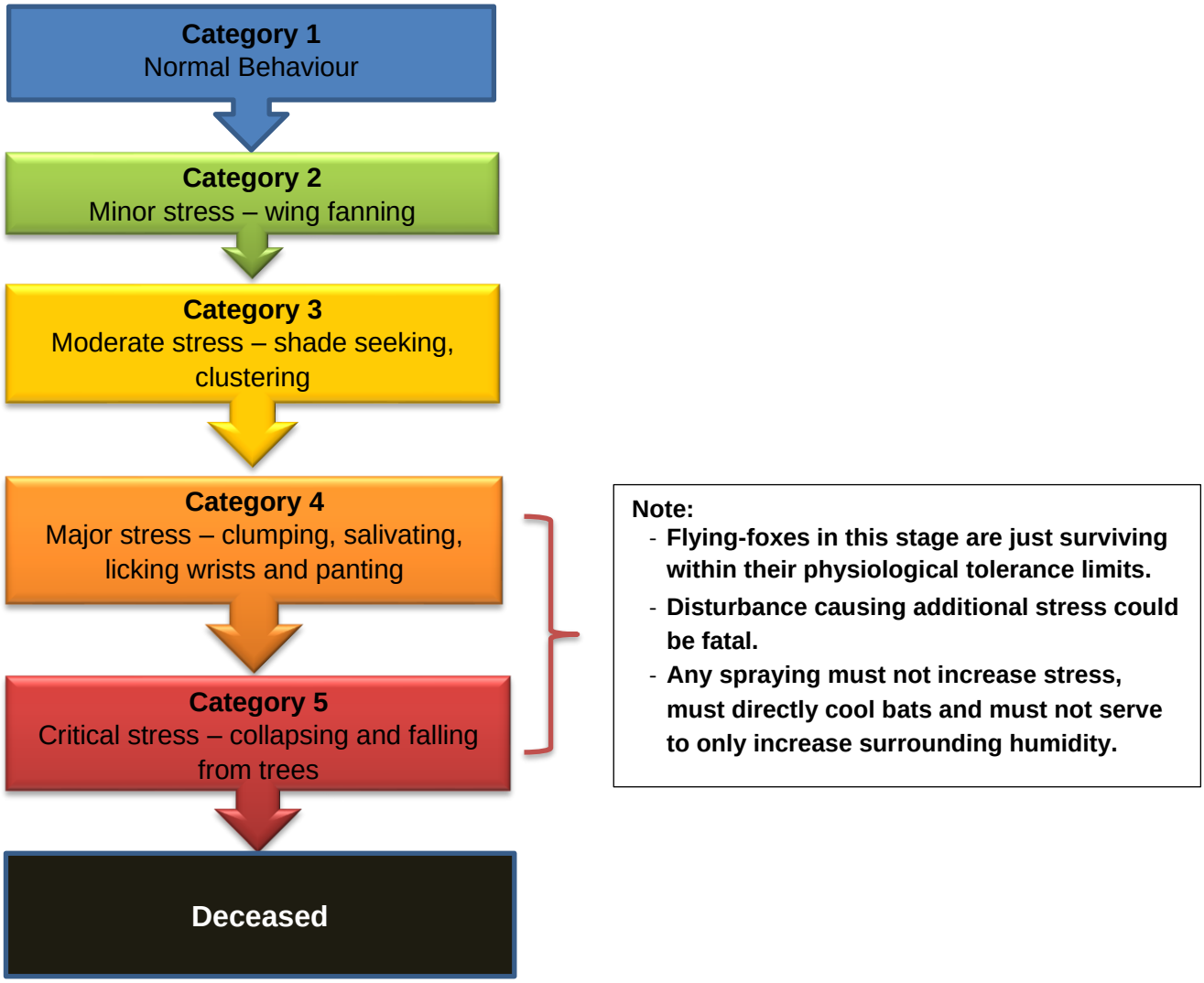
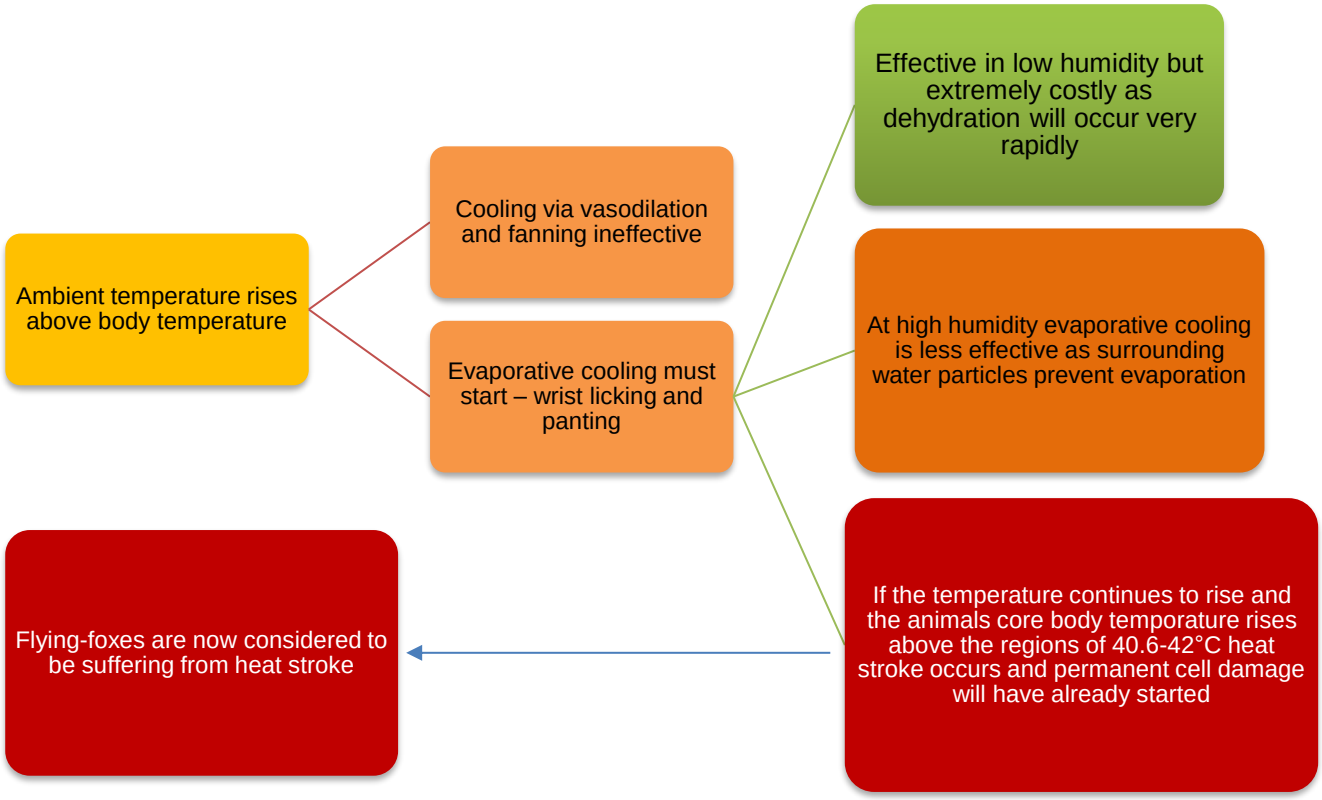


Figure 4: Behaviours and biology of flying-foxes in Category 4 and Category 5 of heat stress



Research shows that of the four main flying-fox species in Queensland, the little red flying-fox has the highest tolerance for extreme heat. This correlates with its vast range over inland areas where ambient temperatures can regularly exceed 42°C.

Black flying-foxes have been shown to suffer higher mortalities than grey-headed flying-foxes, indicating a lower tolerance to higher temperatures. Recent events in Queensland suggests that spectacled flying-foxes have a similar (or perhaps even lower) fatality threshold than the black flying-fox. Pregnant females and juveniles are the most susceptible to heat stress events due to their relatively higher metabolic rates.

Figure 5: Susceptibility to heat stroke based on species

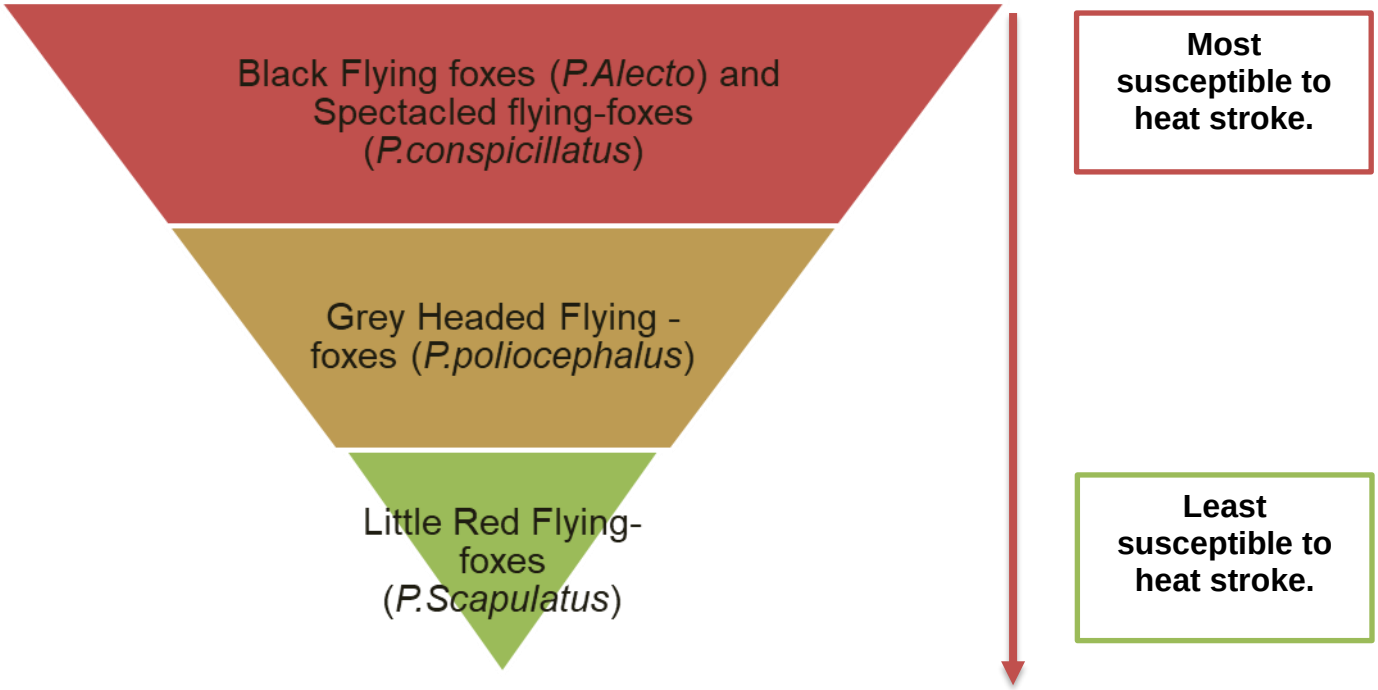
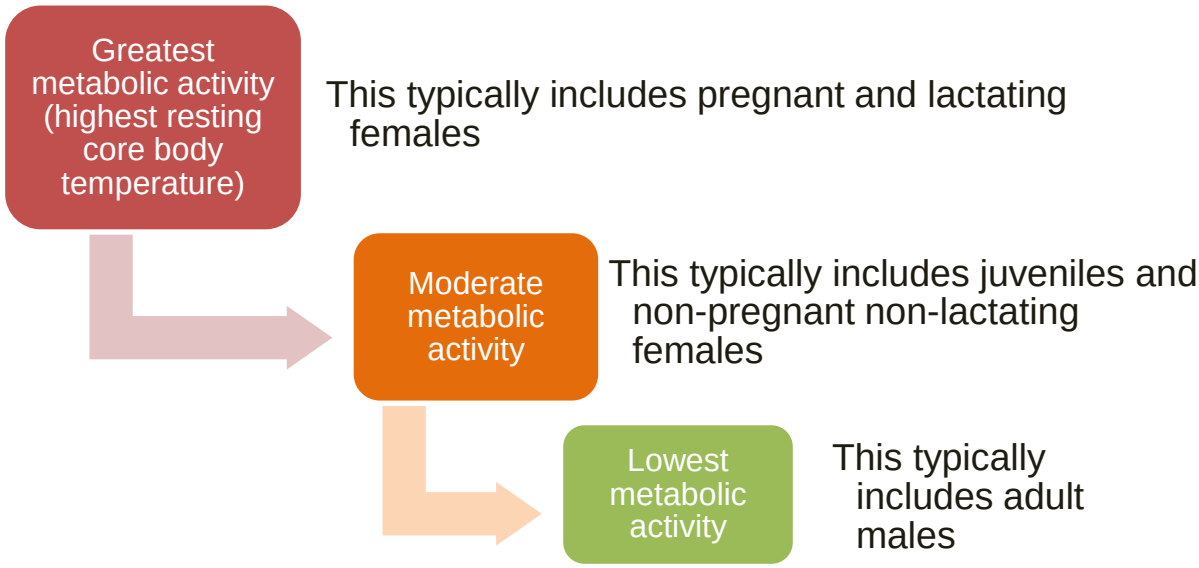


Figure 6: Susceptibility to heat stroke based on metabolic activity - Demographics of the roosts most affected



NB – During late heat events e.g., March/April – Adult males may be affected more due to their metabolic rates increasing as a result of their breeding season

8 Roost site enhancement, preparation, response and recovery

Sections 8.1 to 8.4 of this guideline provide an overview of the processes that should be undertaken to mitigate the effects of a heat stress event on roosts. It must be stressed that it is not possible to save every animal on the day and a triage plan should be followed in order to achieve the ultimate aim of minimising the suffering and deaths of flying-foxes.

8.1 Roost site enhancement

Landowners/land managers should consider creating a roost vegetation structure which includes a canopy, mid-storey and lower/understorey of vegetation. This will help provide shade, enhance the roosts different microclimates, and provide a refuge for flying-foxes, particularly during heat stress events.

The science of what makes a roost heat resilient is still in its infancy. However, evidence from heat stress events and bio-physical modelling of flying-foxes indicates the following factors can influence the numbers of deaths seen during a heat event:

- the air temperature inside the roost
- the relative humidity (higher humidity prevents effective evaporative cooling, conditions of low ambient humidity may cause increased dehydration of the animals over time)
- the wind speed (light to moderate wind speeds help to increase evaporative cooling when flying-foxes have access to deep shade)
- the amount of shading and sunlight on the flying-foxes (a lack of shading and more direct sunlight will exacerbate heat stress).

Consideration of vegetation structure is critical when managing a heat resilient roost site. The structure and cover provided by the ground layer, understorey and canopy at a roost will influence what temperatures and humidity flying-foxes will be exposed to.

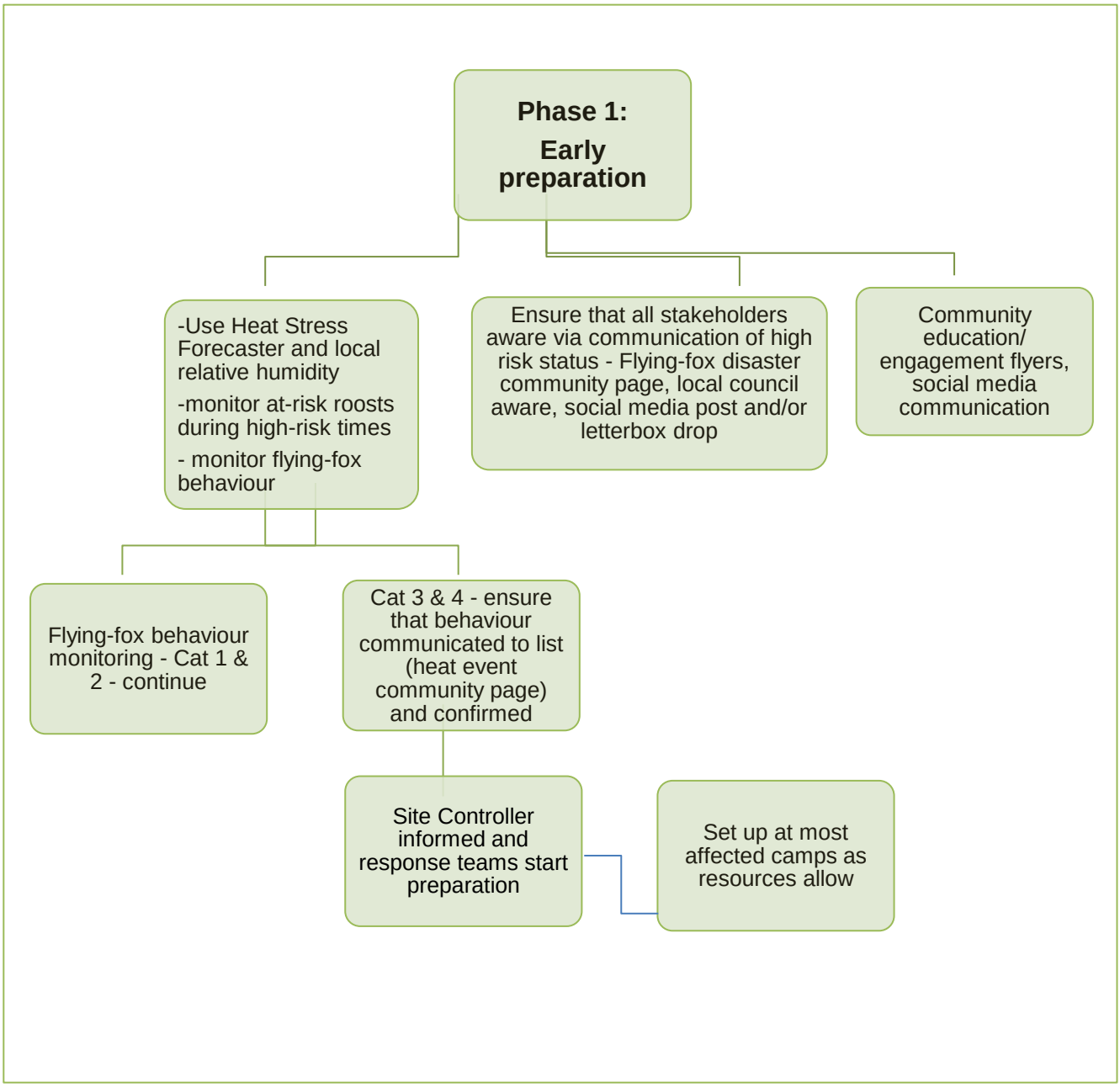
As a rule of thumb, a more heat-resilient roost site will have:

- ample canopy cover
- a relatively dense mid-storey vegetation for flying-foxes to climb down into and shelter from the heat
- substantial ground cover to lock moisture in.

It is well worth considering if previous heat stress event fatalities at a roost site were due to a lack of vegetation structure or changes in vegetation structure over time.

8.2 Preparation

Figure 7: Flow chart of a prepared response to a heat stress event



Early preparation includes the gathering of resources and the organisation of communities, agencies and services who are best able to respond during a heat stress event (refer to *Technical Appendices – Flying-fox heat stress guideline*). This includes addressing site logistics, delineating roles to experienced, trained and available people and ensuring that these people have the necessary equipment on hand to do their jobs.

Early preparation starts with monitoring sites for heat stress. The use of the flying-fox heat stress forecaster (see section 6.1 of this guideline) predicts up to 72 hours beforehand, the roost locations where flying-foxes are likely to experience extreme heat conditions. This gives a heat response team time to prepare their response.

If the decision is made to respond, then clear criteria based on the environmental conditions (temperature and humidity), roost site characteristics and the monitoring of flying-fox behavioural responses during the heat stress event, will determine the best timing and level of intervention. Refer to section 8.3 of this guideline for further information.

8.2.1 Roles, responsibilities, and logistics

Roles, responsibilities and logistics should be planned prior to a heat stress event. Landowners/land managers should consider drafting a roost site specific plan identifying the roles and responsibilities of those people able to respond during a heat stress event. Identifying a site coordinator prior to a heat stress event is critical to good management. A site coordinator will arrange:

- suitable personnel to attend the response (e.g., local carers, flying-fox conservation groups, persons knowledgeable about flying-fox behaviour and vaccinated against ABLV, and other appropriately trained persons)
- coordinate communications between other personnel
- the set-up of site logistics and arrange the supply of the necessary resources and equipment.

Note: Refer to section 3 of the *Technical Appendices – Flying-fox heat stress guideline* for a comprehensive guide to heat event response roles, responsibilities, and logistics.

8.2.2 Workplace health and safety plan

Prior preparation also includes the implementation of a workplace health and safety plan to identify risks and protect personnel from hazards and physical injury, and to address well-being issues.

Addressing the well-being of personnel is essential during a heat stress event as they are physically and emotionally exhausting. Working with flying-foxes in distress or witnessing them dying during a heat stress event can be extremely stressful for all persons involved. Therefore, it is necessary that all persons involved in these events are given appropriate support during and after the event. The Queensland Health website provides resources which may assist in these circumstances: https://www.health.qld.gov.au. Organisations, such as Lifeline (call 13 11 14 for 24-hour support), also provide support services.

A tailored Safety and Risk Assessment Management Process has been developed specifically for use by volunteer organisations and is provided in section 4 ‘Risk Assessment and Management Process (RAMP)’ of the *Technical appendices – Flying-fox heat stress guideline.*

When responding to a heat stress event, the following workplace health and safety procedures should be adhered to:

- provision of site inductions and workplace health and safety inductions for all personnel, including the identification of flying-fox triage parameters
- systems to ensure that anyone handling flying-foxes is vaccinated against ABLV (wildlife care groups should have a list of vaccinated people and copies of proof that they are up to date with vaccinations). For further information on the Australian bat lyssavirus visit: https://www.qld.gov.au/ - search: Australian bat lyssavirus

- procedures in place to ensure that anyone who can handle flying-foxes is easily identifiable (e.g. different coloured armbands denoting vaccinated and non-vaccinated personnel). For further information on safe handling practices visit: https://www.worksafe.qld.gov.au/ - search: safe bat handling. A detailed list of equipment and Personal Protective Equipment (PPE) can be found on the Wildlife Health Australia website: https://wildlifehealthaustralia.com.au/ - search: PPE information for bat handlers
- ensure non-vaccinated personnel are given jobs that do not involve contact with flying-foxes
- systems and resources in place to tag flying-foxes with toe tags to aid with identification of flying-foxes if a responder is scratched or bitten
- medical and mental support available to ensure responders' welfare, for example, personnel available to identify persons suffering from emotional or physical fatigue or heat exhaustion. This can be in the form of a safety officer, first aider or organiser of personnel in the site's break-out area. This person should not be someone involved in the hands-on rescue.

The process of responding to a heat stress event will in most cases bring together a team consisting of different organisations, wildlife care groups and local governments, etc. Each rescue/response, and associated policies and procedures, will vary based on roost logistics, conditions, and resources available. It is important that the collective knowledge of the group is given a platform to be heard and shared.

This could be done in the form of toolbox talks prior to commencing intervention activities, and as learnings or suggestions are discussed during post-event briefings.

8.2.3 Communication

Effective and consistent messaging before, during and after heat stress events is important to ensure effective coordination of the response. Wherever possible:

- consider pre-drafting a template of a standard media response with factual and consistent messaging aimed at providing helpful information to the community. Site specific information can be added later, during the event
- create and cultivate networks of communication between stakeholders (e.g. roost site landowners, local government officers, the department, veterinarians, and wildlife carers) to collaborate logistics, resources and personnel needed to respond to a heat stress event
- facilitate communication channels between these networks of stakeholders (e.g. phone lists, email, Microsoft Teams, social media)

8.3 Response

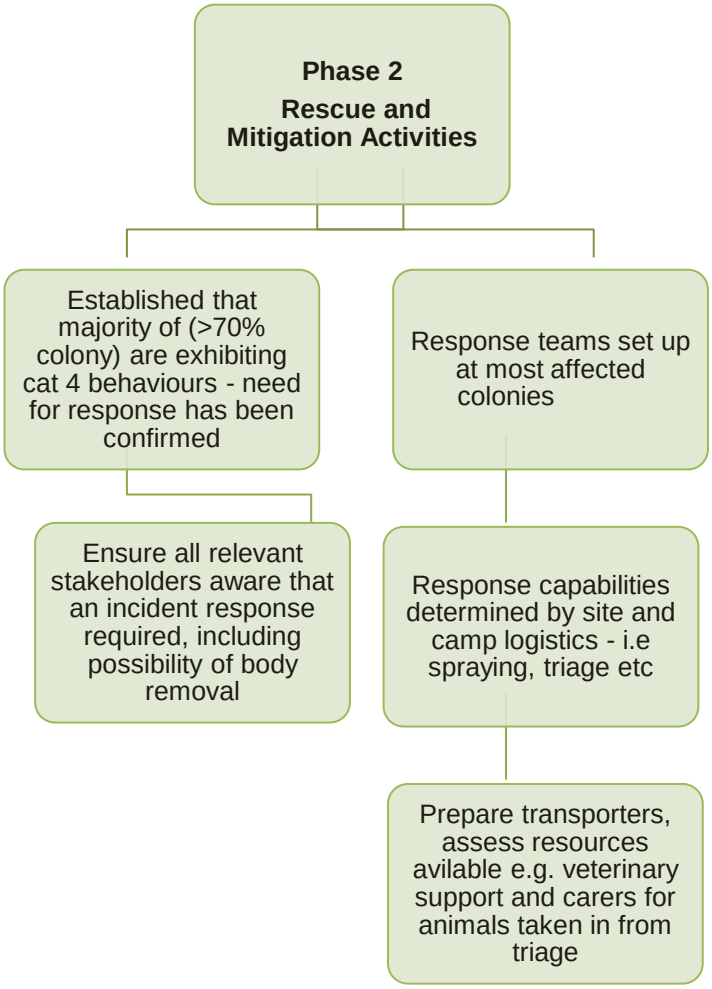
The timing and the mounting of a heat stress response at a flying-fox roost will depend primarily upon the category of heat stress behaviour that the flying-foxes are demonstrating, and the temperatures and humidity being experienced and predicted at the roost site. *Table 1: Flying-fox behavioural guide in heat stress events* shows the categories of flying-fox behaviour and responses thought appropriate at the time of this guideline's publication.

Table 1: Flying-fox behavioural guide in heat stress events

Category	Behaviour	Response
1 Normal behaviour	Normal	None
2 Minor stress	Wing fanning	Observe
3 Moderate stress	Shade seeking	Observe
	Clustering	Observe / prepare for possible response
4 Major stress	Clumping/ Licking	Observe / prepare for possible response
	Salivating	**Do not disturb – These animals are trying to cope within the last of their tolerance limits – imposing additional stress may cause death at this point.**
	Panting	
5 Critical stress	Falling from trees	• Observe in sensitive roosts. • Retrieve to treat only if a vet or euthanasia carer is on-site, leave in-situ if not.
	Seizures/non-responsive	• Observe in sensitive roosts. • In tolerant roosts — retrieve only if an euthanasia carer is on-site; leave in-situ if not. • **Flying-foxes experiencing seizures should not be removed from the roost <u>unless</u> someone licenced for euthanasia is immediately present.**
	It must be stressed that the decision to enter a roost during a heat stress event for the purposes of removing flying-foxes and to administer treatment, may result in large numbers of the animals lifting off to escape. This expenditure of energy by the animals, which will already have limited energy reserves, may cause larger numbers to experience categories 4 or 5 heat stress, leading to death.	
5a Low humidity	More than 70% (majority) of flying-foxes are on ground / disorientated	• Observe in sensitive roosts (i.e., those with flighty/stressed flying-foxes). • In tolerant roosts —direct spray 3 times with 15-minute intervals. Retrieve to treat only if a vet or euthanasia carer is on-site, leave in-situ if not.

5b High humidity	More than 70% (majority) of flying-foxes are on ground / disorientated	• Observe in sensitive roosts (i.e., those with flighty/stressed flying-foxes). • Assess if there is the ability to wet flying foxes safely and directly in the camp (spraying without directly wetting flying-foxes will only increase humidity surrounding the flying-foxes, removing their last protective mechanism to reduce their body temperature). **Ineffective spraying of flying-foxes in high humidity events can be catastrophic.** • In tolerant roosts — direct spray once and observe for evaporation/drying of fur. • If evaporation is occurring, spray 2 more times. • If evaporation is not occurring **cease spraying.** • Retrieve to treat only if a vet or licenced euthanasia carer is on-site.,
6 Deceased	Deceased	• Observe and monitor. • Leave deceased flying-foxes, if possible, for several days if a lactating female is dead. Pups are known to come down to rest with deceased mother several days after death, making live pup retrieval easier. • Collect deceased animals and complete datasheet. • Dispose of deceased flying-foxes as per local government guidelines.

Figure 8: Response flow chart to a phase 2 Rescue and Mitigation at a Heat Stress Event



8.3.1 Making the decision to consider the welfare of the entire population

When responding to a heat stress event it is critical to consider the welfare of the entire population of flying-foxes present at a roost site, rather than that of individual animals. Unfortunately, sometimes not every animal can be saved during these events, and veterinary care may not be available. Therefore, responders need to consider the best welfare options available for the animals overall.

8.3.2 Spraying protocols

Computer modelling indicates that in certain dry heat circumstances, spraying flying-foxes with water can greatly reduce the risk of dehydration and hyperthermia during a heat stress event. However, spraying should **not** be considered where the relative humidity at the roost is high (e.g., over 70-80%) as spraying will inhibit the ability for the animals to cool evaporatively. Under these conditions, spraying **will** increase humidity levels within a roost site and increase the risk of animal mortality due to increased heat stress.

Spraying procedures

If most animals at the roost are exhibiting category 4 (major stress) behaviour of clumping low down in trees, panting, salivating, and licking their wrists:

- assess the tolerance of the flying-foxes to a quiet approach
- if mass lifting occurs or flying-foxes are showing signs of elevated distress, then the animals are not tolerant to approach. **Cease actions** and continue to monitor behaviours
- if tolerant, attempt to spray flying-foxes directly using water in easily transportable, low noise spray mechanisms (e.g. backpack spray) using the following process:

    1. start gently with the stream as a good spray using large droplets at low force
    2. gradually increase the intensity of the spraying so that each animal becomes saturated with water
    3. monitor the response of the animals
    4. immediately cease spraying if any flying-foxes are starting to lift off or become more distressed
    5. move on to observe the next area and come back and observe the previously sprayed flying-foxes after 15-minutes
    6. if the animals are drying off between sprays, continue with another spray, if not, cease spraying as humidity may be impeding evaporative cooling
    7. after 3 attempts at spraying, and if resources allow, remove animals that are not responding for triage (i.e. those that are not climbing back into the mid-storey near to the ground)
    8. do not immediately remove orphans that are roosting in trees as mothers will often come back for babies once the situation has settled. It will become apparent over the next 24 to 48 hours if pups and juveniles are truly orphaned
    9. ideally all animals brought in for triage should be seen at a wildlife veterinary facility, as they will all have some form of systemic damage due to heat stroke which can only be addressed adequately and humanely with intensive veterinary treatment.

8.3.3 Flying-foxes on the ground

- Live animals on the ground should only be retrieved if a veterinarian or licenced euthanasia carer is on-site, otherwise they should be left in-situ.
- Non-responsive or dead animals should not be retrieved unless a veterinarian or euthanasia carer is onsite, otherwise they should be left in-situ.
- If a lactating female is found dead (active feeding nipple observed), where possible, leave the animal in-situ, for several days. Pups have been known to come down to rest with deceased mother several days after her death. This aids in easier live pup retrieval.
- If live young are observed on deceased females, retrieval is only advised if the roost is tolerant of close human contact and a veterinarian or euthanasia wildlife carer is available to provide treatment.

8.3.4 Triage protocols

It is important to determine triage protocols during a heat stress event as this will determine the priority of each flying-foxes' treatment based on the severity of their condition. In some cases, it may also be essential to triage resources to aid those animals that can feasibly be rehabilitated.

Ideally, at least one person licenced by the Queensland Department of Health in wildlife euthanasia and sedation practice by should be present during any heat event response operation. However, it should be noted

that the numbers of trained and vaccinated carers and access to resources and veterinary support varies widely across Queensland. Responders need to evaluate what resources are available on site when deciding which animals to take on for triage and rehabilitation to maximise their chances of survival. Efforts should also be made to outsource help if possible.

Triage – removing flying-foxes from roost for triage

Where resources allow, and when the decision to triage flying-foxes has been made, flying-foxes showing category 5 (critical stress) behaviours, and that meet the following criteria, should be assessed for triage at the heat stress site or taken in for veterinary treatment:

- nonresponsive or appear to be deteriorating
- deteriorating despite spraying (in situations where spraying has been deemed suitable)
- are not responsive at all during spraying.

These animals are likely to have significant multi-organ damage requiring intensive management and veterinary care. In addition, animals undergoing seizures and those with obvious additional injuries, need to be taken in for triage/veterinary treatment.

During triage, take the following actions:

- where possible, all flying-foxes brought in for triage should be seen by a veterinarian
- use judgement as to whether an animal is having a seizure, is non-responsive or is injured and should be removed. If moving these animals compromises the ability to spray a large group and/or is disturbing them and causing added distress, it is best to leave those animals having seizures, that are non-responsive or are physically injured, in-situ. Any additional stress at this point could mean death for all the flying-foxes in a group
- ideally, if resources allow and a suitable veterinarian or licenced carer is present, administer Pamlin @ 0.5mg/kg intramuscular (IM) to any responsive flying-foxes. This will help to mitigate the effects of myopathy; halt further increases in body temperature and reduce anxiety in handled animals
- those animals undergoing a seizure should be given an IM dose of Pamlin @1mg/kg or via the rectum (Pamlin will be readily absorbed via the rectum, and this may be a safer option than an injection under these circumstances)
- administer glucose orally with either a Glucodin powder paste, or as not more than 1ml of concentrated liquid; Glucose can also be administered on the gums, subcutaneously (SC) or intravenously in a fluid form. Glucose can readily cross the mucous membrane into the blood stream, even in quite shocked flying-foxes
- animals that have responded to 3 sprays and have shown good improvement in demeanour but are not 100% recovered should be given 10% (SC) fluids (50:50 2.5% Glucose/saline and Hartmann's)
- monitor rectal temperature initially and then every minute until the rectal temperature drops below 40°C
- after internal temperature drops below 40°C stop spraying with tepid water and use fanning - either manually to increase air movement over animals or using battery powered fans
- continue to monitor rectal temperature every 2-5 minutes after this time as shock can cause the temperature to drop rapidly, causing the animal to go into hypothermia as shock worsens
- place False Tears in all flying-fox eyes (gel is best)
- note any animal that may have regurgitated during rescue or triage for veterinary attention

- leave non-euthanised dead mothers in place for a few days where possible, as this often aids the rescue of orphaned young who may come down from roost trees
- place animals in transport cages once their temperaments are stable and the rectal temperature is stable (at 37-38 °C), and Oral Mucous Membrane Capillary Refill Time (OMMCRT) has been approximately 2-3 seconds or less for a period of at least 10 minutes – continue to monitor these animals for regression every 10 minutes
- if seizures recur in these animals or the body temperature drops below normal again and they are not responding to repeat treatment – euthanasia is required
- animals that do not immediately respond to spraying within the roost (i.e. move back into the mid-storey) but have rapidly recovered with basic triage (glucose on gums and one dose of SC fluids, and have stable rectal temperatures after spraying) can be kept in care for 72 hours and then returned to the wild or released if no veterinary facilities are available.

Flying-foxes brought in during a heat stress event should **not** receive hydration via an oral fluid. Animals will appear desperately thirsty, however, the blood supply to the stomach will long since have shut down rendering the absorption of fluids impossible until other means of rehydration can restore this blood supply. If given oral fluids, the fluid will sit in the stomach and be regurgitated leading to aspiration pneumonia as a complication. In these cases, subcutaneous fluids will be needed - many animals will be incapable of responding to anything other than veterinary intensive shock treatment and IV fluids.

Triage – Flying-foxes requiring immediate euthanasia

Some flying-foxes with the following symptoms/behavioural issues will require immediate euthanasia in the following cases:

- seizures are not controlled after treatment with Pamlin and glucose and/or cooling.
- severe respiratory distress
- initial rectal temperatures of over 41.5°C
- blind / non-responsive animals
- animals with concurrent physical injuries, for example, fractures and severe lacerations
- animals whose rectal temperatures drop below 35°C and have OMMCRT of greater than 3 seconds and do not respond to SC fluids and warming.

Triage - Orphans

When a heat stress event occurs at a roost with both pups and dependent juveniles present, orphaned animals may not be immediately apparent. In such cases, take the following actions:

- search the roost for weak and emaciated juveniles in the days following a heat event to identify those animals needing to be brought into care
- note that some juveniles will come down to dead mothers left on the ground up to 2-3 days after the heat stress event
- take care not to remove healthy juveniles whose mothers may return
- when observing the camp for orphaned young, ensure that any activity within the roost is stopped by 5.30pm so that normally crèched juveniles are not mistaken for orphaned young
- orphaned young during heat events will be suffering from a degree of heat stroke and resultant organ damage and will require specialised care

- all orphaned young collected during a heat event should be seen by a wildlife veterinarian, to determine if treatment for aspiration pneumonia and adequate fluid therapy (with or without gut protectant treatment) is required
- aspiration pneumonia is extremely common in orphaned flying-foxes experiencing heat stroke – orphans will often be hypoglycaemic, and their gastrointestinal (GI) tracts are often damaged by heat and will not absorb nutrients and fluids normally
- orphans' body condition and development needs to be closely monitored, as their ability to absorb nutrients from formula in care is different to that of normal orphaned flying-foxes
- fluid therapy is vitally important for at least the first week following a heat stress event and oral feeds should not be started until orphans have been rehydrated adequately and supplemented with glucose
- an initial feed of Glucodin should be attempted (not more than 2ml) and the amount given orally should be increased gradually, to avoid aspiration and resultant pneumonia
- feeds need to be increased conservatively as the GI tract will also have compromised ability to digest and absorb, due to damage.

8.3.5 Transportation of flying-foxes

Appropriate procedures are vital to ensure the welfare of flying-foxes during transportation:

- wherever possible, transport each animal in separate cages (this will assist in limiting potential ABLV clusters if one animal is found to be infected)
- open wire cages to allow good air flow
- ensure that each box is positioned to allow air flow to reach all animals in transport
- ensure that transport has air-conditioning and that any holding cages have adequate air flow through the cage, in order to reach the wildlife hospital or carer in the best condition possible
- ensure that the wildlife hospital or carers are prepared for the flying-foxes' arrival
- **do not** wrap up flying-foxes before placing in transport cages or place covers over the cages - this will prevent further radiated or evaporative cooling even if the towels are wet and will continue to increase the body temperature of the flying-foxes
- **do not** offer flying-foxes oral fluids post heat event rescue – they are at risk of aspirating at these times
- ensure that all cages are secure to prevent accidental opening or excessive movement during transport.

8.4 Recovery

Incident debriefing and data collection are essential for those involved to collectively learn from heat stress events and to improve responses to heat stress events into the future.

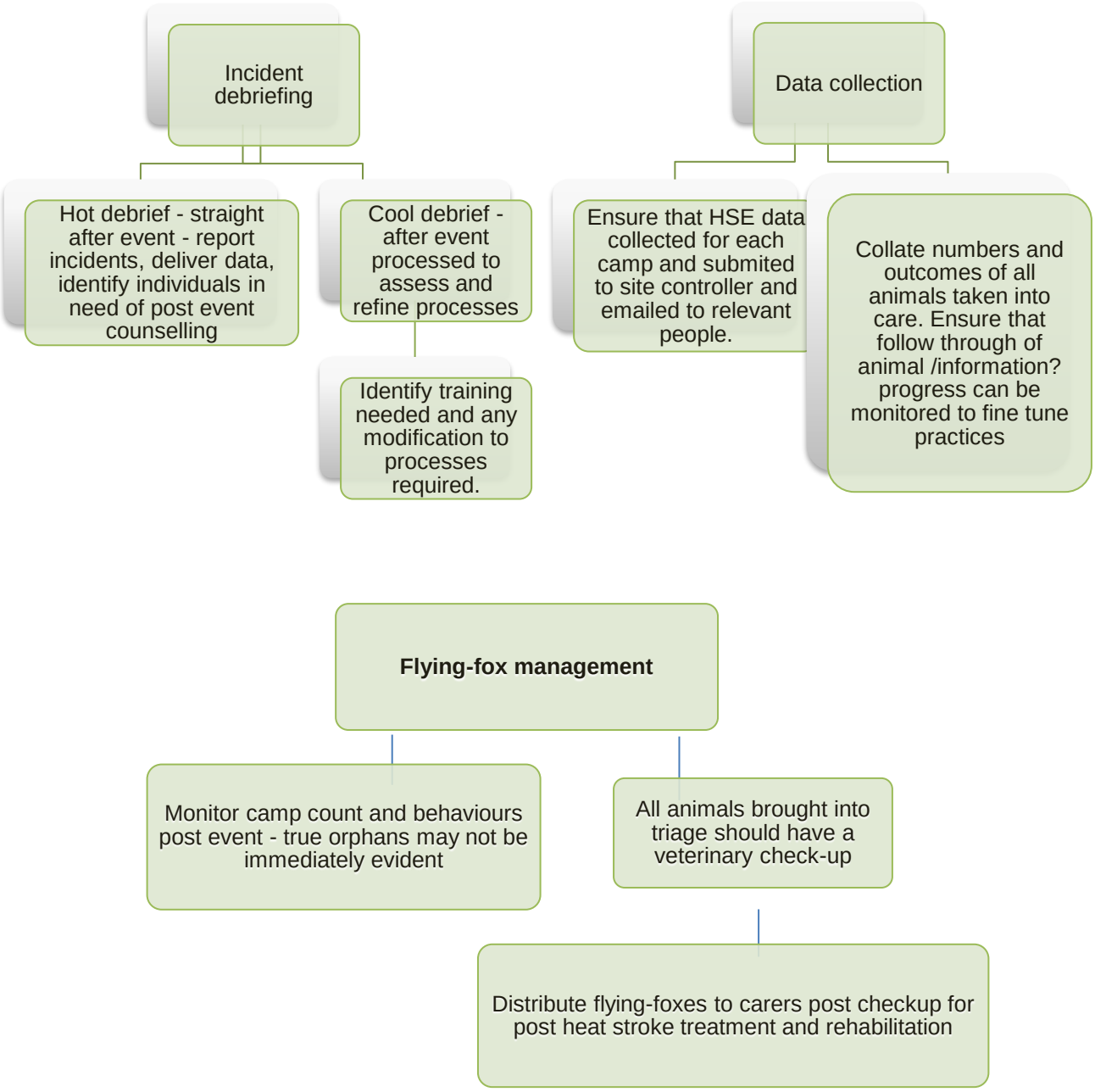
Figure 9: Recovery shows a flow chart identifying incident debriefing, data collecting and flying-fox management steps. Debriefing allows the heat event to be processed to assess and refine processes, identify training required and identify individuals in need of counselling.

Data collection for each roost, such as numbers and outcomes of all animals taken into care should be submitted to the site coordinator and disseminated to appropriate stakeholders.

Concerning the flying-foxes themselves at a roost, it is essential to continue monitoring the animals and their behaviours post event. Some animals may still be sick, and orphans may not be immediately evident. All

animals triaged should be checked by a veterinarian and distributed to carers post-check-up for treatment and rehabilitation.

Figure 9: Recovery



9 Reporting

Reporting on individual flying-fox heat stress events provides valuable information on the effect of these events on flying-fox populations as a whole, allowing for enhanced responses to such events in the future.

The following procedures can be used:

- collect data through a hot debrief immediately after the event and then at a cold debrief at a later time to provide a comprehensive overall event picture. Hot and cold debriefs:
  - allow analysis of techniques that worked well, did not work well, and how procedures can be modified and/or improved
  - facilitate emotional support of those involved
  - enable better preparation and responses for future heat stress events
- enter data, such as dates, roost name and number of flying-fox deaths, on the 'Flying-fox heat-stress data form' (refer to section 5 'Heat stress data recording' of the *Technical appendices – Flying-fox heat stress guideline*), or an alternative form which is available on the flying-Fox heat stress forecaster web page: https://www.animalecologylab.org – search: flying-fox heat stress forecaster – data form.
- document progress and outcomes for flying-foxes receiving veterinary treatment and those taken in for triage to carers, including orphans - include all relevant medical data
- report any animals found dead or alive (with bands attached) to the Australian Bird and Bat Banding Scheme (ABBBS) via: https://www.dcceew.gov.au - search: ABBS On-line reporting form
- report any animals with radio-tracking collars to owners (details should be on the radio tracker)
- retain a copy of any data for use locally for future heat event responses
- provide event data to the relevant local government and the department via the incident or site coordinator
- keep a record of lessons learnt and modifications required for future responses related to each site
- data should be collected using the form located in section 5 'Heat stress data recording' of the *Technical appendices – Flying-fox heat stress guideline* and the completed forms sent to the individuals listed on the form in addition to the carer group and local council where requested.

10 References

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***Human Rights Act 2019* compatibility**

The department is committed to respecting, protecting and promoting human rights. Under the *Human Rights Act 2019*, the department has an obligation to act and make decisions in a way that is compatible with human rights and, when making a decision, to give proper consideration to human rights. When acting or making a decision under this guideline, officers must comply with that obligation (refer to Comply with Human Rights Act).

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Approved By

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