Managing Heat Stress in Flying-foxes Colonies

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Message from the Authors

Collectively the authors have been present during twenty Heat Stress Events (HSE's) from 1994-2020; ranging from severe (4000 deaths) to moderate (200 deaths); from Kyogle, Cabramatta, Emu Plains and Adelaide. Fifty nine (59) high temperature days (≥42˚) have also been monitored from 2000 - 2020.

The one constant throughout a HSE is; bats will die. How many deaths will be determined by a number of contributing factors; these are listed on page 6.

Our role in these events is to hopefully reduce the number of deaths and support the bats until the temperature drops. How successfully we can influence this outcome will depend upon;

- prior knowledge that a HSE is imminent
- how well you know your colony
- number of volunteers
- how accessible is the colony
- what resources are available.

We hope this presentation together with your own experiences will be of assistance in preparing for future events.

Our own encounters have demonstrated that when you are prepared for an event and you have an understanding of how these animals are trying to protect themselves; you can assist and make a difference. It is those events that catch us off guard that are the most devastating. For the authors these have been experienced at both the Kyogle and Cabramatta Creek colonies.

We must emphasize before you begin reading; that no two colonies are the same and no two heat events are the same.

We wish you every success with future heat stress events.

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Pictures taken by Sonya Stanvic, Viki McDonald and Fauna Rescue SA
Heat Stress Events at Cabramatta, Emu Plains and Adelaide.

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Know Your Colony

Due to the number of factors that impact a HSE (page 6) it is important that all colonies within your area are monitored regularly from November through February.

Recording the number of animals occupying the colony , species present, social structure, available food resources as well as temperature provides valuable information on how the flying-foxes within your colonies are likely to cope and survive a HSE.

As this is the busiest time of the year for wildlife organisations responsible for the care of orphans and injured adults; monitoring colonies can be difficult. However please consider; while you may save 100 animals during the course of a season; monitoring your colonies has the potential to save many thousands without the added stress of having to bring hundreds more animals into care.

Challenges

1. Summer temperatures are rising. The number of flying-fox colonies experiencing temperatures >40^{o} C each year is increasing. The maximum temperatures recorded during heat extremes is trending higher.
2. Consecutive days of high temperatures and the number of high temperature days experienced by a single colony each season are also increasing.
3. Black Flying-foxes (*Pteropus alecto)* are recording significantly higher deaths during HSE's than Grey-headed. Dallas Park Jan 2002 and Southeast Queensland Jan 2014; 95-98% of deaths recorded were Blacks. The Casino colony death toll in Nov 2014 was approximately 94% Blacks.

What is a Heat Stress Event?

HSE's occur when the temperature within the colony is ≥42˚C . As a result of these high temperatures flying-foxes will suffer varying degrees of heat stress. How the colony response to these high temperatures occurs in stages as the temperature climbs throughout the day. These stages are described in detail beginning page 18.

What is Heat Stress?

Heat stress occurs when the body absorbs or produces more heat than it can dissipate. This process can be fatal as the heat regulating mechanisms of the body become overwhelmed and are no longer able to effectively deal with the heat, causing internal body temperatures to climb rapidly leading to severe dehydration and vital organ failure.

What factors Impact on the Severity of a Heat Stress Event

There are many contributing factors that will impact on the number of animals affected during a Heat Stress Event.

- High temperatures ≥ 40˚C
- Speed at which the temperature is rising
- Wind speed and direction
- Time of the event: November- December - January - February
- Animals access to adequate understory vegetation
- Number of animals occupying the colony
- Number of lactating females
- Number and age of juveniles
- Condition of the animals prior to the HSE
  - Has there been an adequate food source prior to the HSE
  - Has the colony had an influx in numbers just prior to the HSE
- What species are present (Blacks-Greys-headed-Little Reds)
- How accessible is the colony
- What resources are available to assist the animals

Adelaide Colony

At the time of this 2019 revision the Adelaide colony has experienced 53days of temperatures ≥ 40˚C from 2014 - 2019, fifteen of these have resulted in deaths. The relevant data to analyse these events has been recorded. An example of the data collected on the environmental conditions that impact these events is available Appendix 7 page 33.

The added data required to monitor this colony comes from monthly counts; this provides information on the number of animal's present, new arrivals and social structure (males, females, birthing etc). Weights and forearm measurements on animals coming into care and collected by researchers provides information on the condition of the animals within the colony.

Fauna Rescue SA Flying-fox Team would like to share this data in the hope that it will assist in your preparations for future HSE's.

Temperature

The temperature at which animals will begin to suffer the effects of heat stress will vary from colony to colony and species present.

Current information indicates that when **temperature is the only influencing factor**; fatalities do not occur until temperatures are ≥42˚C. In colonies containing only Grey-headed Flying-foxes' temperatures can be higher before fatalities occur in significant numbers (≥44˚C). See Appendix 7 page 35 .

Speed at which the Temperature Rises

High temperature days currently monitored, show an average rise of 1.6˚C per hour.
Range 0.8˚ - 2.2˚.

Most colonies will not reach their highest temperature until after 2pm AEDT (Australian Eastern Daylight Time).

Colonies that reach temperatures ≥42˚C by 12pm AEDT indicates a rapid rise.

Casino November 2014 reached its highest temperature by 11.30am (44.1˚C) with a rise of 5.3˚per hour (see table below). The Adelaide colony has only recorded one rapid rise in temperature; reaching maximum temperature by 12.30pm at a rate of 3.3˚ per hour.

When the temperature is predicted to be ≥40˚C begin monitoring temperature as well as wind speed and direction as early as possible. Until more information is available on Black Flying-foxes; all days indicated to be ≥38˚C should be recorded.

Wind Speed and Direction

Wind speed and direction will have a greater impact on colonies with poor understory vegetation (see understory vegetation page 9) and/or containing Black Flying-foxes. Blacks are slower to move from the canopy trees.

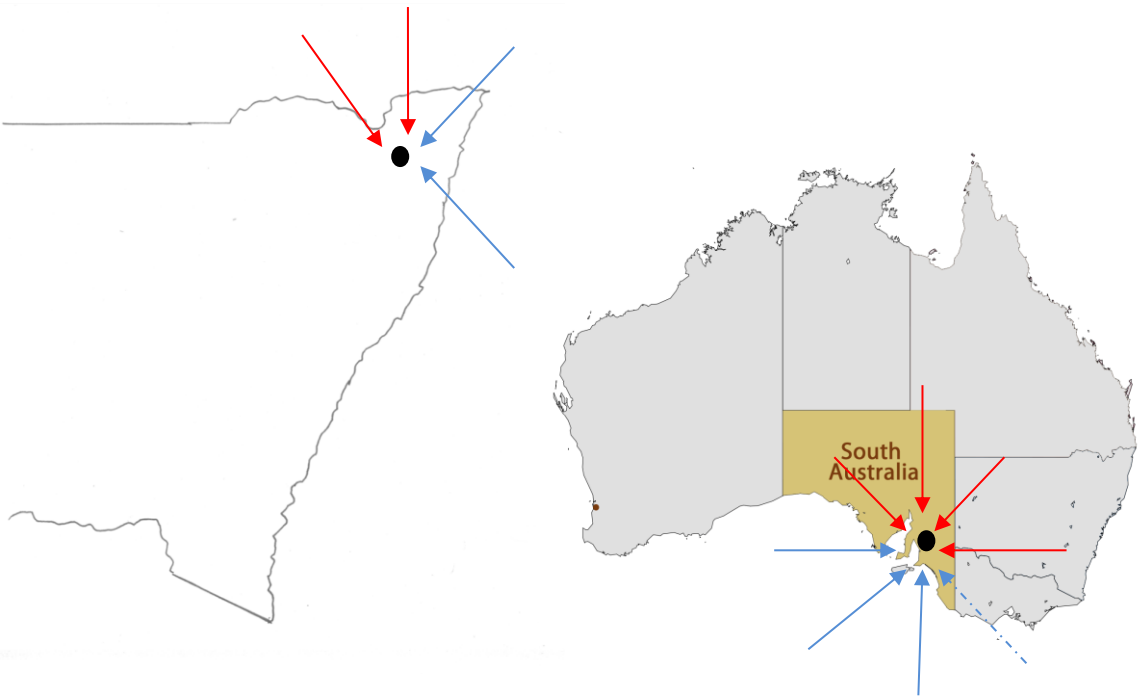
The lower the animals can descend into the understory the less they will be affected by hot winds and strong gusts.

The examples below show wind direction. Is the wind coming from over the ocean or hot and dry from inland and at what speed?

What impact will this have on your colony as the temperature rises.

Casino 15th November 2014				
Time	**Temp**	**Humidity**	**Wind Direction**	**Speed**
9.00am	30.8	43	NW	24
11.30am	44.1	18	N	44
3.00pm	42.3	20	NNE/ESE	13

Justin Welbergen 2014



Time of the Event - Nov - Dec - Jan - Feb

The animals most affected during HSE's are lactating females and their young. Heat events that occur November/December have a higher impact on lactating females. During these months mothers cannot separate from their young.

Flying-foxes use evaporative cooling to elevate heat stress (panting, salivating, wrist licking and urinating). Lactating females need to expend more energy and resources keeping both themselves and their young cooler. Dehydration occurs more rapidly.

To date there is insufficient data on the number of lactating females that die during these events. However, the number of adult deaths recorded during November (Singleton - Casino - Northern Queensland) and the number of young coming into care (many removed from their dead mothers) indicates a high mortality rate for females. More data is required to assess the impact of November/December HSE's on lactating females.

Date	LA Females
Jan-14	1.6%
Jan-18	0.0%
Feb-15	1.0%
Nov-19	15.5%

Adelaide LA – Lactating Females

Data recorded on Adelaide's first significant November HSE illustrates the impact these events can have on lactating females.

January/February will see juveniles separate from their mothers. In much the same way they do when their mothers fly out at night to feed. Many of these juveniles can also fly short distances so can move to cooler areas of the colony.

HSE's during January/February will have juvenile packs forming throughout the colony. The death rate for juveniles can be high during these months.

However, if you are able to spray these packs, they will respond rapidly and survive.
See Spraying Flying-foxes During HSE's page 17
also Stage 3 page 20 and Juvenile's page 24.

January/February HSE's - low adult mortality

Date	Females	Juveniles	Males
Jan-14	6 (4LA)	237	2
Jan-18	0	112	0
Feb-15	9 (6LA)	618	4
Feb-17	5 (3LA)	80	26

Adelaide LA: Lactating Females

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All HSE where under 1000 animals have died, this includes animals collected after the day of the event were processed (weights, forearms, sex, age and reproductive status). Events resulting in a higher number of deaths, approximately 20 - 25% of animals were processed.

The Importance of Understory Vegetation

Most flying-fox colonies have ground covers and understory vegetation that are classified as weeds. However, removing the understory vegetation will have a severe impact on the number of bats that die during a HSE. Flying-foxes need understory vegetation to escape the intense heat.

Although weeds such as Lantana, Morning Glory, Balloon and Madeira Vines will save animals during a HSE; they will eventually destroy the canopy trees. Bush regeneration programs must find a balance and adopt a systematic approach for the removal of weed species. The Cabramatta Creek Colony used a mosaic pattern for weed removal; each section was approximately 4metres squared.

Emu Plains

When developing a bush regeneration program within a flying-fox colony the following needs to be considered; How much of the understory can be removed before the bats are compromised. Will the remaining understory support the colony during the next HSE? At what time of year will the understory be removed and how long will it take for re-plantings to provide adequate cover?

When understory vegetation is removed; flying-foxes will move to a different location within the colony. This has occurred in many colonies including Gordon, Wingham Brush, Cabramatta and Emu Plains. If too much understory is removed, they may not return to the colony for a number of years.

During the Emu Plains HSE of 2005; temperatures reached 45˚C. With adequate understory and using a water tanker; no deaths were recorded. In 2013 temperatures reached 46.5˚C; however the temperatures taken amongst the Lantana and Wandering Jew were 3 - 4 degrees cooler. Only 18 animals died and 3 juveniles were removed during this HSE.

Cabramatta Creek Colony has experienced a number of problems with their understory vegetation. In 2002 Ibis moved into the colony and established a rookery which destroyed a large proportion of the understory. During the 2003 HSE temperatures reached 45˚C and 200 animals died. The Ibis have since moved on and an extensive revegetated program undertaken. In contrast during the 2013 HSE temperatures reached 46˚C; however, the temperature in the understory was again 3 - 4 degrees cooler; only 10 deaths were recorded and no animals removed.

Examples of Understory Vegetation

Adelaide Colony

The Adelaide colony is to the right of these trees and has no understory vegetation. The bats fly to this area of the park as the temperature rises.

Centennial Park Sydney

The Centennial Park colony has low level understory but no mid-level vegetation

The colonies below have multi-level understory vegetation. The flying-foxes will move lower and lower into this understory as the temperature rises (see Stage 3 page 20).




Alecto's (Black Flying-fox)

To date over 90% of deaths occurring in mixed species camps have been Black Flying-foxes.

Current observations indicate that Blacks remain in the canopy of their roosting trees for longer and are slower to actively seek out the coolest areas of the colony in the same way as Greys-headed and Little Reds. As a result, they exhibit heat stress at lower temperatures.

The only way to support animals during HSE's is to understand their behaviour.

Most high temperature days do not result in a HSE however, wildlife care organisations responsible for colonies containing large numbers of Black Flying-foxes need to monitor and record all days with a predicted temperature ≥38˚C; to establish a history of behaviour.

Although animals may not die at 38˚C their behaviour changes. By comparing behaviour to temperature (see example Appendix 6 page 32) you can provide the appropriate support when a HSE occurs. A behavioural data sheet for printing is available page 37.

Condition of Animals Prior to HSE

When the body condition of the animals occupying the colony is lower than average, this can have a significant impact on the animal's ability to cope during a HSE. By recording the forearm measurement as well as the weight, on all animals presented for rehabilitation prior to a HSE and observing food resources; you can predict that animals may succumb to heat stress at lower temperatures and/or in greater numbers.

New arrivals to the colony can have an impact on our ability to support the animals when spraying is indicated. New arrivals are flightier when the colony is entered. Being aware of these situations will enable you to better understand and support the animals during a HSE.

Extreme Heat Events

Extreme heat events are those which result in mass die offs. These events can occur within a single colony or over multiple colonies on a single day (Southeast Queensland 2014 - Northern Queensland 2018). The temperature at which these extreme events occur depends on what species are present and usually includes a number of added factors listed on page 6.

Regardless of how prepared you are there will be HSE's that are beyond our ability to support.

Adelaide January 24th 2019; temperature forecast 45˚C.

Adelaide had recorded data on a previous event at 45.1˚C and were aware that the body condition of the animals was the lowest recorded since their arrival in 2010.

We were prepared; or so we thought.

The temperature reached 45.5˚ C by 1.30pm - 46.6˚C by 3.30pm and did not drop below 40˚C until 8.30pm (Duration: 8½hrs ≥ 42˚C with 5½hrs ≥ 45˚C).

During the event carers were supported by Adelaide City Council workers, Botanic Garden staff, Adelaide Zoo staff and Vets, RSPCA members, Adelaide Museum staff, independent Vets and DEW employees.

However, even with all this assistance 4,000 died with only 106 animals brought into care. The colony count was estimated at 16,000.

TIME	TEMP
12:00	42.0
12.30	43.7
1:00	44.0
1.30	45.5
2:00	45.7
2.30	45.6
3:00	46.0
3.30	46.6
4.00	45.2
5:00	45.0
5.30	45.5
6:00	45.3
7:00	45.4
8:00	42.1
9.00	38.5

Data recorded from West Terrace Weather Station1.2klms from colony

Casino colony Nov 2014 experienced five identifiable factors that could have contributed to this extreme event.

- High temperature
- Rapid rise in temperature
- High winds
- Time of event - November
- 65% of animals present were Black Flying-foxes

Temperature Monitors

Most HSE's in flying-fox colonies occur during January/February however, Singleton in November 2003 recorded 44.1˚C. More recently Casino November 2014 also 44.1˚C and Northern Queensland November 2018. Unpredictable temperatures can occur at any time therefore, it is recommended that all colonies be monitored from November through February. There are a number of online weather sites that provide 7 - 10 day forecasts.

During the months November through February communication should be ongoing between Temperature Monitors and/or Flying-fox Coordinator/Site Coordinator; to ensure any pending weather conditions that could result in a HSE are not overlooked.

As one never knows what the weather will do until the actual day; if the forecast is for temperatures ≥40˚C, all colonies should be checked and plans put in place to have volunteers on standby.

Organising Heat Stress Events

Each colony will have its own unique challenges and each Wildlife Care Organisation will need to develop their own procedures and protocols.

HSE's are highly charged emotional situations; to ensure a good outcome for the bats and the safety of the volunteers attending these events, some pre-planning needs to be established.

THE FOLLOWING INFORMATION IS A BASIC GUIDE ONLY.

Flying-fox Coordinator

Most wildlife care groups within the range of the flying-fox will have a Flying-fox Coordinator. The Flying-fox Coordinator is usually the first point of contact for flying-fox related incidents.

Prior to the month of November, the Flying-fox Coordinator will need to compile the necessary information to execute a heat stress program should it be required. This should include contact details for councils, government agencies and organisations that can provide support.

The Flying-fox Coordinator can take-on a number of responsibilities and/or enlist the help of others to carry out specific functions.

COMMUNICATION BETWEEN NOMINATED POSITIONS IS THE KEY TO THE PROGRAMS SUCCESS.

Organising Volunteers

The Flying-fox Coordinator or nominated person should compile two lists of volunteers who can be contacted if and when they are needed for a HSE.

List 1. Vaccinated carers: name-contact numbers-current titre-equipment.
List 2. Non vaccinated persons: name-contact numbers-what jobs they can undertake to enable vaccinated carers to focus on the animals.

The Flying-fox Coordinator or nominated person should provide all volunteers with a list of what they are required to wear (OH&S), bring for themselves and for the flying-foxes; as well as a map of the colony showing the designated meeting point. These lists will vary from colony to colony & group to group however, a minimum list is provided in Appendix 1 page 27.

The Flying-fox Coordinator or nominated person should also instruct volunteers not to enter the colony until they have registered with the Site Coordinator.

Site Coordinator

On advice from the Temperature Monitors that a HSE maybe imminent the Site Coordinator (if not the Flying-fox Coordinator) should contact the Flying-fox Coordinator and together assess conditions within the colony.

The Site Coordinator should be an experienced flying-foxes carer; familiar with the colony they are about to enter and supervise.

The Site Coordinator will be responsible for the welfare and organisation of the volunteers once they arrive. The Site Coordinator should where possible wear a reflective vest so that they are clearly recognisable, this will aid the volunteers in identifying who is in charge.

The Site Coordinator should have a sign in sheet (see Appendix 4 page 30), and ensure volunteers complete all details before they enter the colony; and sign out when they leave.

As volunteers arrive and sign in the Site Coordinator will assign specific tasks to be determined by the greatest need.

The Site Coordinator will be required to allocate areas or grids for the spraying teams.

Volunteers

On arrival volunteers must report to the Site Coordinator and sign in. You may be assigned to triage, spraying and monitoring the colony or the operations area. All volunteers entering the colony must be vaccinated and work in pairs. Do not deviate from your assigned task without informing the Site Coordinator. If a particular area has been assigned to you and you move out of this area without informing the Site Coordinator; animals from that area may no longer be monitored.

Vaccinated Volunteers

Vaccinated volunteers' primary responsibilities will be triage and spraying bats. Vaccinated carers should be identifiable to the rest of the team. In SA vaccinated carers wear red armbands.

Non Vaccinated Volunteers

Working in the operations area filling water containers. Ensuring that the vaccinated volunteers working in the colony remain hydrated. All administrative work such as; sign in sheets completed, documenting animals brought into triage, phone calls and organising transport for animals that need to be moved out etc.

Red armband denotes Vaccinated

Sprayers

Sprayers must be vaccinated, work in teams (minimum two) and carry flagging tape. The colony should be split into areas or grids and each team will be responsible for spraying and removing the animals from their area.

This is an effective way of supporting the animals as each team will become familiar with the animals in their allocated area; they will know which bats have been sprayed and when. Tagging trees will help identify groups of animals that require further observation; either during the spraying program, or when the temperature drops and/or the following day.

When animals are entering Stage 2 (see page 19) of a HSE; a few spraying teams should enter the colony to assist bats that may have begun clumping. Clusters can also be approached; however, if the bats are still flying to escape your presence; back away; (see Stage 3 page 20) for more information.

NOISE MUST BE KEEP TO A MINIMUM WHEN WORKING IN THE COLONY

Triage

Triage is the classification of casualties to determine priority of need and treatment. During a HSE a number of flying-foxes may need to be removed from the colony for more intensive cooling and rehydration. The most obvious will be live young on dead mothers, lactating females and geriatrics.

Triage should be on the perimeter of the colony in a **QUIET SHADY LOCATION**. All triage personnel attending bats must be vaccinated and have experience in administering all forms of fluid therapy.

Only carers dropping off animals and coordinators should be allowed in this area. Triage should be separate from the operations area and noise kept to a minimum.

Triage needs to be well organised and each carer assigned specific duties. This will ensure animals are adequately hydrated, do not become chilled and animals that have recovered remain stress free while waiting to return to the colony.

Treating Animals in Triage

Treating one animal for heat stress can be more personalized to suit the specific needs of the individual; however, the information in this section is for large scale application and relevant to a HSE that has been monitored through all stages of the event.

Extreme HSE's or events that have not been monitored from the onset can present with a much higher number of animals experiencing severe heat stress symptoms.

Each Wildlife Care Organisation will have their own procedures for rehydration. However, all flying-foxes entering triage need to have their temperature reduced and stress kept to a minimum. Animals must be treated in a shaded area, preferably in wire cages on hammocks. Air flow through a damp towel will also help reduce ambient temperature. Animals can be lightly sprayed with **tepid** water.

By lowering the ambient temperature, the animal's own thermoregulation responses can recover.

Once the animals' temperature has been reduced you will find that a high percentage of animals will respond to oral fluids.

Oral fluids must always be administered with the animal turned to the side. Dehydration can affect their swallowing reflex. By feeding at the correct angle you avoid aspiration.

The correct angle for administering fluids

Young naturally feed in this position

Do not administer fluids in this position

Most animals that are brought into triage can be returned to the colony when the temperature drops in the late afternoon. This only applies for HSE's that do not have a high adult mortality and the following days temperature is expected to be <40˚C.

Operations Area

Operations area must be located away from triage. The operations area will be where:

- Volunteers sign in/out
- Buckets for washing hands are set up
- Water containers for spraying bats are placed etc
- Volunteers personal items are stored (water bottles, sunscreen etc)

Basic Timetable for Impending Heat Stress Event (AEDT).

10.00am AEDT

Assess colony - observe the position of the animals and their condition.
Are the animals moving down from the canopy; are they fanning.

10.30am to 12.30pm AEDT

Contact carers to be on standby and expect to arrive at the colony between 12.00pm to 1.00pm.

Arrange for a small group of carers to arrive between 11.00am and 12.00pm to help monitor the animals, set up triage and spraying equipment.

For those colonies that can enlist the services of water tankers this would be the time to make contact.

1.00pm AEDT

By this time most of the animals will have moved down low and closest to the river/creek/coolest areas of the colony. Those monitoring the colony will know where the animals of greatest need are and whether they are approachable.

Volunteers should be organised in pairs and allocated an area of responsibility within the colony.

2.00pm to 3.00pm AEDT

Volunteers should move amongst the animals quietly & keep movements to a minimum; begin spaying.

PLEASE NOTE

If at any time animals begin to fly to escape your approach back away and try again later.
By adding to the stress experienced by these animals during a HSE your efforts to assist may lead to increased mortality.

Equipment for Spraying Flying-foxes During HSE's

Water Tankers

Water tankers were first used at the Cabramatta Creek Colony in Sydney in 2003 and have been successfully used in a number of colonies since this time.

Cabramatta 2003

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Colonies that can employ the services of water tankers have the capacity to reach a larger number of animals. However, as we have stated throughout these notes; timing is paramount (see page 17).

The animals need to be low enough for the water to be sprayed above (see Stage 3 pages 20-23). The primary objective for using water tankers is to provide much needed fluids for dehydrated animals, over a greater area.

Colonies where water tankers have been used have observed volumes of animals licking vigorously and with relief; from the water the tankers provide.

Sprayers

Again, spraying animals began at the Cabramatta Creek Colony 2002; after 2000 animals died in 2001 (43.8˚C). These were only handheld sprayers (see photo page 22) however this year only 200 animals were lost, even though the temperature was significantly higher(45˚C).

These sprayers to date have been most effective.

- They can hold from 5-8 litres of water
- They allow you to stand 2metres from the animals
- They deliver a good mist/spray; with adjustable nozzle
- They have a handle and a shoulder trap

Backpacks can also be used; however be aware they can be extremely heavy holding up to 20litres of water.

Spraying Flying-foxes During HSE's Is All About Timing.

In line with rising temperatures flying-foxes gradually move to the coolest areas of the colony (see Stages of HSE starting page 18). For some colonies this will mean moving to a different area and/or moving into the understory vegetation. We must allow this process to proceed without interference. If we intervene too early the animals will expend more energy trying to escape our efforts to assist.

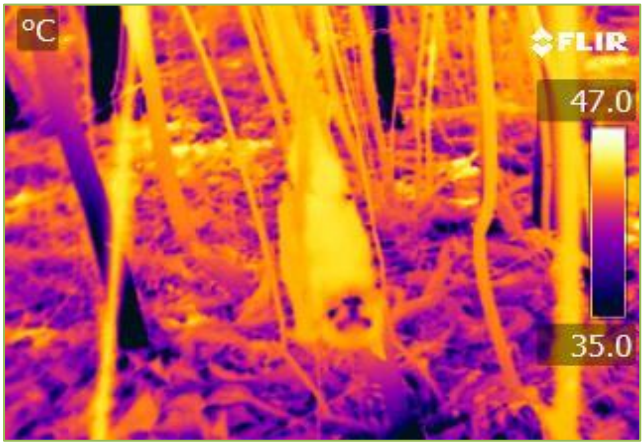
Stage 1

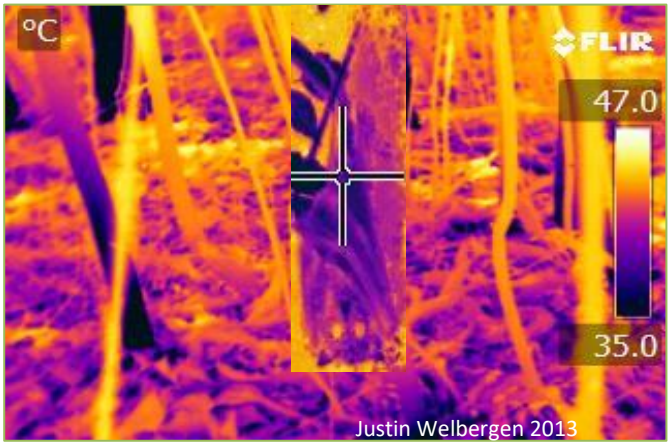
The animals in the photo to the left are still moving to cooler locations. No volunteers should enter at this stage and it is too early to engage water tankers. Although the animals are beginning to move lower, they are still too high for spraying to be effective. Intervening at this stage will force the animals to move back into the canopy where the temperature is higher; causing further stress (see Stage 3 page 21).

The animals in the photo to the right are now occupying a cooler area of the colony. They are shaded and low. This is the time they need our assistance.

Stage 3

The thermal imaging photo below left; shows the flying-fox has moved to a cooler location at ground level however, the animal is still hot. The image on the right shows the animal when sprayed. Spraying animals in the coolest locations within their colony is when spraying is most effective. This allows their body temperature to recover and provides much needed fluids.





Timing is Paramount

During a HSE the time to begin assisting the animals is critical. Too early and they move away. Too late and many animals will be past heat stress; suffering heat stroke then death.

STAGE 1

The timing of each stage is a GUIDE ONLY

Time frame for Stage 1: Approximately 10.00am to 12.00pm AEDT
(Australian Eastern Daylight Time)

Normal Roosting Position

When temperatures reach approximately 38˚C flying-foxes start to suffer from the heat.

Fanning is no longer effective.

They begin to move closer to tree trunks and thicker foliage to escape direct sunlight (also see photo Stage 1 page 17).

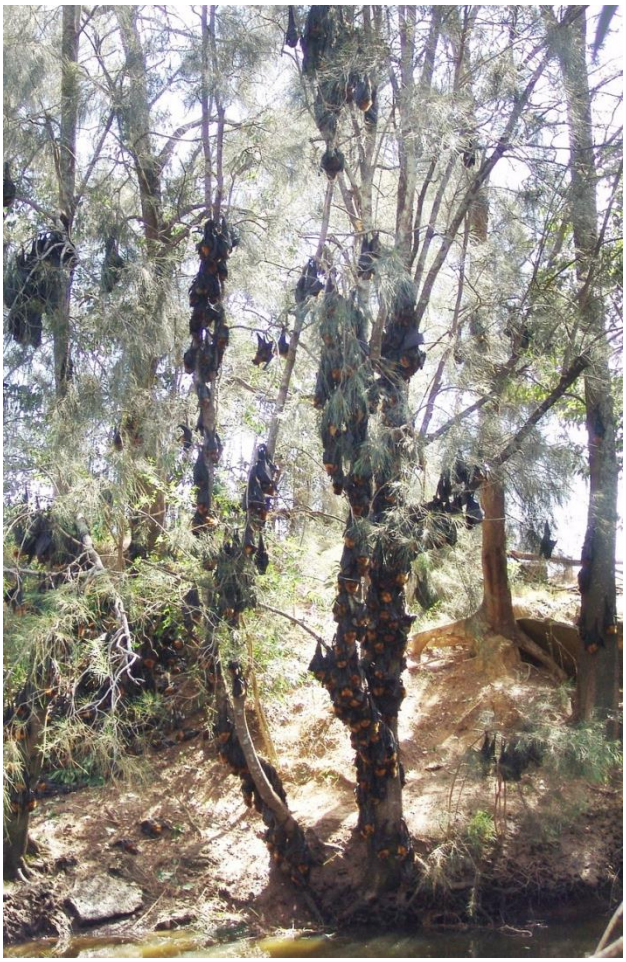
This is clustering not clumping (see photo next page for clumping)

At this stage you should not attempt to approach the bats; they will fly away or move back into the canopy where the temperature is higher.

Observe only and document behaviour and position within the colony.

STAGE 2

Time frame for Stage 2: Approximately 12.00pm to 2.00pm AEDT



When temperatures reach approximately 40˚C flying-foxes will continue to move lower into the understory vegetation and to ground level.

Clumping is a term used when flying-foxes roost on top of each other; these can be found:

- on the shaded side of trees
- in the understory
- at the base of trees
- under logs (see page 22)
- in tree hollows
- on the ground

Clumping

These 'clumps' can have up to, and in excess of 50 flying-foxes in them. The animals are now becoming heat stressed and will have difficulty managing their body temperatures through stage 2.

Usually at this stage you still cannot successfully approach the bats. They continue to be fearful when approached and capable of moving away and/or flying.

However, you can begin to observe at a closer proximity and some clumps/clusters may be receptive if approached slowly using equipment that can deliver water from a minimum distance of 1-2metres.

Spray just above the animals first as this will prevent them from immediately beginning to climb. If they are ready for assistance they will begin licking.

If they continue climbing; back away immediately and try again later

STAGE 3

Time frame for Stage 3: Approximately 2.00 - 3.00pm (AEDT) until temperature drops.

The temperature for stage 3 is approximately 42˚C - 44˚C and will depend upon which species is present (Grey-headed - Black - Little Red).

At this stage, the animals are at their lowest; both in their position within the colony and their physical condition.

This stage can be very confronting; it is important (although difficult) not to become too overwhelmed. We are there to assist the bats and to only remove those animals that are not responding to spraying.

Stage 3 is the time you can approach the bats and begin spraying in earnest. If you spray just above the animals while slowly approaching, they will immediately start licking the water as it flows down their body and will not care how close you are.

The number of volunteer's available will determine the most achievable outcome during Stage 3.

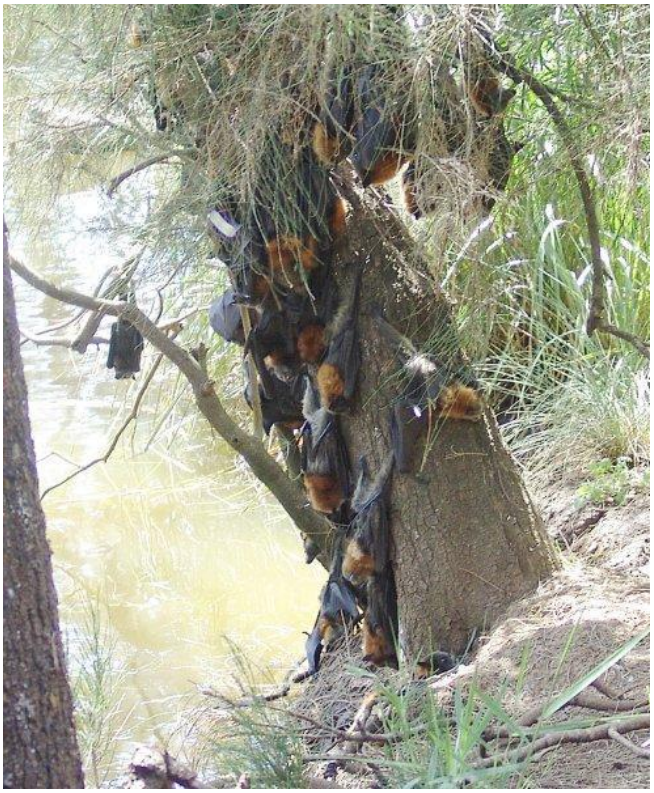
We are using photos in this section to illustrate how you can reduce the number of deaths and keep the removal of animals to a minimum.

Clusters like these can be found throughout the colony. When the animals in the photo on the left were first viewed; they were thought to be dead and dying. When sprayed (right hand photos) they can be seen actively licking water and very responsive. These animals were sprayed regularly over the next hour and moved off the ground to hang low in the trees. No animals were removed. All were back in the canopy by late afternoon.

STAGE 3 cont:

Panting

Clustering



Clumping

Spraying animals with hand-held equipment and/or water tankers is most effective when the animals are in the areas of the colony illustrated in the photos on this page.

The animals are now within the coolest areas of the colony, where the temperature can be a few degrees lower.

Hand sprayers should be able to reach the highest animals, the water tankers slightly above and over a larger area. This allows the water to filter down.

As soon as the animals start licking; hand sprayers can target animals directly and begin spraying the lower animals.

Always spray the highest and greatest concentration of animals first. If you approach the lower animals first, you risk disturbing the main group.

STAGE 3 cont:

Clumps can contain as many as 50 animals (photo below). These clumps can be broken up by spraying. If you can get to these clumps early you can reduce the number of deaths and remove some of the animals for more intense rehydration. However, we have found that most of these animals can be returned to the colony when the temperature drops.

While it is not easy to see from this photo; the bats hanging here are on top of other animals wedged under the log

By spraying the animals, you can see on both sides of the log; you can get them to move out and up so you can now reach the animals underneath.

In this photo, all animals were on the ground. After being spayed some are now moving higher. The volunteer is watching the animals still on the ground for an appropriate response. Those not responding will be brought in for further assessment & rehydration.

Just to give you an idea how quickly these animals can respond; no animals were taken into care from this group.

Each pair of volunteers has a set area to monitor. These animals were checked and sprayed a number of times throughout the afternoon and by the evening were all back in the canopy

This is the stage for using water tanker where available; see Appendix 3 page 29 for technical Information from the Avoca Beach Rural Fire Service at the Avoca Colony NSW.

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What are the Flying-foxes doing through Stages 1, 2 & 3

We have looked at the Stages of behaviour during a HSE; now with the help of Justin Welbergen thermal imaging we can illustrate why.

Photo top left: Normal photo shows two flying-foxes moving down the tree truck.
Photo bottom left shows why: They are on the shaded side of the tree where it is cooler.

If we give the animals time to protect themselves; we can move in at the right time and provide support until the temperature drops.

See thermal imaging page 17 on how spraying will support the animals and why assistance and not removal is the most desirable outcome.

Juveniles

There is an understandable misconception that juveniles found alone during heat stress events must indicate that their mother is dead.

Observations made during the first and second stages of a HSE show there is a separation that occurs between females and their young; similar to when mothers leave the colony at night to forage.

The result of this behaviour during a HSE is; clusters of juveniles like the photo below, will be found throughout the colony.

Do not remove; assist by spraying

We know from past January/February HSE's that at least 94% of deaths can be juveniles, the remaining 6% will be made up of, males-lactating females-non lactating females and geriatrics. Therefore, it is safe to conclude that most surviving juveniles still have mothers alive within the colony.

There are HSE's that have recorded a high mortality in adults. These are usually colonies in which thousands of animals die and higher numbers of **orphaned** juveniles will be encountered.

The photo above was taken during the HSE in Emu Plains 12th January 2013. There were 5000 - 6000 animals occupying the colony at this time. This is a cluster of approximately 40 juveniles.

The reaction of the first group of volunteers on site was to collect these animals. However, on advice the animals were sprayed not removed.

The ambient temperature of the Emu Plains Colony was 47˚C. The temperature in the understory was 42˚C-44˚C. Eighteen animals died during this HSE: 16 juveniles and 2 adult males. As no females died; all juvenile clusters had surviving mothers in the colony.

This comment was made by an observer in the colony on that day. "*By sunset all the 100s of lethargic juveniles that were piled on the ground and at the base of trees earlier in the day had evaporated. When the colony was thoroughly checked the following day not a single juvenile was found in trouble; all were reunited with their mothers".*

Juveniles cont:

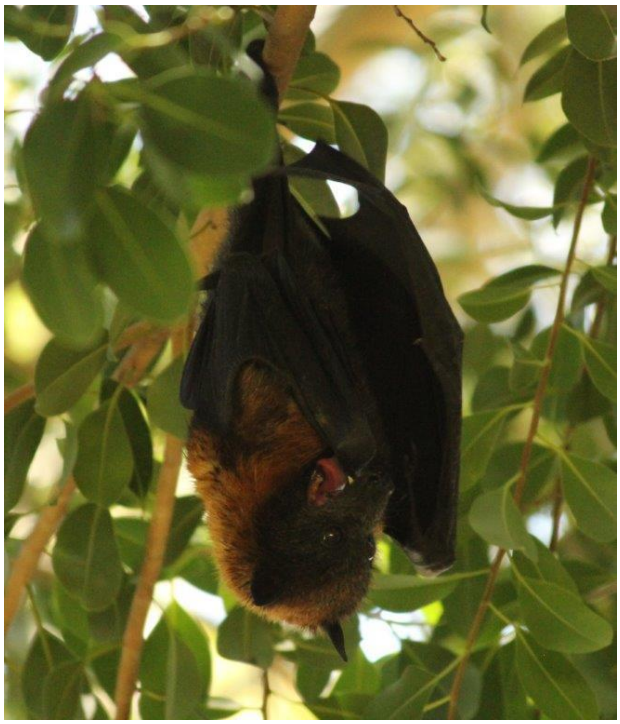
The two young juveniles in the photos below were from the Cabramatta HSE January 2003. They are both hanging about 2 feet off the ground; one low in a tree the other on a stick. Both are surrounded by other juveniles, most on the ground. These animals were sprayed regularly throughout the afternoon but not removed. The trees they were in or near were tagged and checked that evening and the following day.

These animals are vigorously drinking the water provided and their eyes are bright. They do not need to be removed

Animals die during heat stress events; many will be juveniles; an unfortunate fact that we as carers witness all too frequently. Some events are overwhelming, others manageable.

If we can with confidence allow the juveniles to return to the canopy to be reunited with their mothers; then we will reduce the impact of the event for all the surviving members of the colony.

Wrist Licking



The Adelaide colony is located in a public park within Adelaide City and has no understory vegetation.

The colony is checked daily by Botanic Park ground staff and Fauna Rescue SA contacted when dead bats are found.

All flying-foxes returned to the colony on the evening of a HSE have their toe nails painted. If they are found after an event they can be identified.

To date no tagged animals have returned.

The animals in the top photo are the same animals from the huge clumping in the right hand corner; 3 hours later.

This is a section of the colony at 6.00pm

There are still animals down low, these were monitored until just before dusk and the colony checked over the following days.

This is the same area 3 hours earlier; 3.00pm

Recording and Disposing of Bodies

Where possible after a HSE bodies should be processed and the number of deaths, sex, age, weights, forearms and reproductive status documented. Also check dead bats for bands and/or microchips if possible.

If you are unable to process the animals on the day of the event, consider utilising the services of organisations that have access to cool rooms or freezers; RSPCA, Vets, Ag Departments etc.

If the number of deaths is high, consider using a percentage of the animals for specific data collection. During the Adelaide HSE January 2019, 1000, of the 4000 dead were processed over the month following the event using cool rooms and freezers to preserve the bodies.

Where practicable the disposing of large numbers of bodies should be by a hazardous waste contractor due to health risks; this should be discussed with local councils.

Appendix 1: Volunteers

Dress Code and Equipment for Volunteers

Volunteers should not be permitted to enter the colony if they are not wearing the following items.

1. Long pants
2. Long sleeved shirt
3. Closed in shoes
4. Hat

Volunteers will also be required to bring the following

1. Drinking water (minimum 4 litres)
2. Sunscreen
3. Insect repellent
4. Protective gloves
5. Two tea towels: During the afternoon, these tea towels can be wet and worn around the neck or under the hat

Equipment Volunteers will need to bring for the Flying-foxes

1. Cat Carry Cages/Bat Cages that allow air flow.
2. Towels (minimum of 6 marked with name).
3. Drinkable water for the bats (2 - 4 litres).
4. Spray bottles/pump sprays.
5. Plastic syringes.

Coordinators will provide you with a list for any additional equipment that may be required.

Volunteers Occupational Health & Safety Requirements

1. Only vaccinated persons with an appropriate current titre will be permitted to enter the colony.
2. Volunteers should not enter the colony until they have contacted the Site Coordinator and completed the sign on sheet.
3. All volunteers working in the colony must work in pairs.
4. Volunteers should not deviate from instructions without consulting the Site Coordinator.
5. Do not climb trees.
6. Use marked trails where possible.
7. Beware of snakes and spiders.
8. All bites & scratches to be washed immediately & registered with appointed person.
9. Sign out when you leave. This allows the Site Coordinator to know you have not had an accident, become lost or hurt somewhere in the colony.

Appendix 2: Committee

List of Equipment to be Organised by the Flying-fox & Site Coordinators

1. First Aid Kit
2. Volunteer Registration Sheets
3. Animal Registration Sheets
4. Tables (operations area-triage)
5. Soap + 2 Buckets (for washing hands if bitten or scratched)
6. Spraying Equipment
7. Water Containers to fill the spray bottles and pumps
8. Flagging Tape; multiple colours (for marking trees & cages)
9. Lectade
10. Hartmans + Needles
11. Hazard Waste Container
12. Body Bags
13. Face Masks + Vicks (when collecting dead bodies this will helps with the smell)
14. Pegs (have a multitude of functions)
15. Arm bands to identify vaccinated personnel.
16. Latex Gloves
17. No wash disinfectants

The Committee will also need to organise

1. Who will take animals that require removal from the colony.
2. Stand by teams to check the colony on the days following the HSE.
3. A map of the colony showing access points would be helpful for the volunteers.

Appendix 3: Information from Avoca Beach Rural Fire Service

Information from Avoca Beach Rural Fire Service

Captain Leigh Pilkington and his team assisted during the January 2013 heat stress event at Avoca and has provided the following information.

THE TECHIE DETAILS (that can be passed on to other fire services):

Our site was very flat with great access along each side. Canopy was thick and a dense understory. After some experimenting, we found that 25mm canvas hoses of the end of live reels with three-way directors gave us the reach and spread that we needed - approximately 800kpa pressure was doing the trick. Along the sides of the colony where the canopy was dense and there was no breeze to drift the mist with, we shot over the top of the canopy where we could and let the water drop down on the canopy - similar to techniques we would use to attack a pole fire.

Many of the flying foxes would get on the wing even with water being sprayed indirectly or at some distance, but they generally circled back into the wet foliage which was ultimately the aim.

At the ends of the colony where prevailing winds could push it in some distance, we used short lengths of 38mm canvas and fog nozzles at 230L/min and fogged as much as we could to allow it to drift. This was where the greatest impact was. The three-way directors: with a fairly spread jet or cone was also pretty good.

We found even just wetting the understory was helping as it raised the humidity in the canopy above (we assume). The gentler the spray the less likely they were to take to the wing. We generally moved down the flanks of the colony at about blacking out speed - didn't need to saturate things and found it more effective to get in and wet a big area a little - rather than one area really well.

Hope that helps

Other fire brigades can contact Leigh and his team at captain@avocafire.info

Please remember the primary objective for using water tankers is to provide much needed fluids for dehydrated animals, over a greater area.

Appendix 4:

Heat Stress Event Sign In/Out Sheet: _____/_____/_____

By completing these details, you are acknowledging that you have a current & appropriate titre or are not vaccinated. If you are not vaccinated or you do not have an appropriate titre and you enter the Colony; you do so at your own risk. By completing this sheet, you are also agreeing to abide by the instructions given to you by the Site Coordinator

ORGANISATION BRANCH	NAME	PHONE HOME - MOBILE	ADDRESS	VACCINATED YES / NO	TIME IN	TIME OUT
		H				
		M				
		H				
		M				
		H				
		M				
		H				
		M				
		H				
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Appendix 5: Data required for ongoing research

https://www.animalecologylab.org/heat-stress-data-form.html

HOME RESEARCH PUBLICATIONS PRESS PEOPLE JOIN RESOURCES

Flying-fox heat-stress data form

BACK TO FORECASTER

Please fill out this form if you have information about how flying-fox camps have fared in recent heatwaves (this applies to both affected and unaffected camps). Your inputs will help build a repository of flying-fox heat stress events and develop a more comprehensive understanding of the impacts on the species. They will also reveal the scale of the public service that wildlife volunteers provide during these events, which will help in generating much-needed government support initiatives.

* *Indicates required field*

Date of event *

Contact *

Camp name *

Roughly how many bats were in the camp? *

Did any bats die? *
- Yes
- No

If yes, approximately how many bats died?

Species present
- grey-headed
- black
- little red
- spectacled

Of those that died, approximately what percentage was:

young

adult

Of those that died, approximately what percentage was:

grey-headed | black | little-red | spectacled | unknown

Any comments/observations that you would like to share?

Were any bats taken into care?
- Yes
- No

If yes, how many (approximately)?

Upload file (optional)

Choose File No file chosen

Max file size: 20MB

Upload file (optional)

Choose File No file chosen

Max file size: 20MB

SUBMIT DATA

Appendix 6: Comparing Behaviour to Temperature

Behavioural Observations

Please fill out as many cells below as you can. If you miss a time period, please leave the corresponding row blank and move on to the next one. Tick (✓) if observed or cross (X) if not observed. Leave blank if not assessed.

Time	Wing fanning	Clustering	Panting	Licking wrists / wing membranes	Bats on ground	Bats dead	Comments/observations (e.g. movements within & between trees, or towards water)
10:00	✓	X	X	X	X	X	Arrived 10am all bats fanning
10:30	✓	✓	X	X	X	X	Clustering under canopy vegetation
11:00	✓	✓	X	X	X	X	Moving to cooler amphitheatre trees
11:30	✓	✓	X	X	X	X	
12:00	✓	✓	X	X	X	X	
12:30	✓	✓	X	X	X	X	Clumping down tree trucks
1:00	✓	✓	X	X	X	X	Some spraying began
1:30	✓	✓	X	✓	✓	X	
2:00	✓	✓	✓	✓	✓	X	All animals now receptive to spraying
2:30	✓	✓	✓	✓	✓	✓	Spraying is working well
3:00	✓	✓	✓	✓	✓	✓	Moving from low to higher vegetation
3:30	✓	✓	✓	✓	X	✓	Moving from trunk to branches
4:00	✓	✓	X	X	X	✓	Some bat now wrapping
4:30	✓	✓	X	X	X	✓	Mothers with young hanging side by side after spraying licking vigorously
5:00	✓	✓	X	X	X	✓	Some animals starting to move higher
5:30	✓	✓	X	X	X	✓	
6:00	✓	✓	X	X	X	✓	
6:30	✓	X	X	X	X	✓	
7:00	✓	X	X	X	X	✓	
7:30	X	X	X	X	X	X	Released rehydrated animals
8:00	X	X	X	X	X	X	

Temperature

Time	Temp	Humidity
6:00am	26.2	32
7:00	25.6	38
8:00	34.9	15
9:00	38.6	11
10:00	40.3	10
11:00	41.3	10
12:00	42.8	10
1:00	44.2	11
2:00	45.1	11
3:00	43.2	11
4:00	35.7	23
5:00	37.3	20
6:00	37.1	17
7:00	37.7	34
8:00	32.3	28
9:00	30.8	35
10:00	31.1	31
11:00	31.4	28
12:00	30.4	35

Appendix 7:

Example of data collected on high temperature days. Duration ≥40˚ Maximum temperature

January 2018

	Thursday 18/01/18				Friday 19/01/18			
Time	**Temp**	**Humidity %**	**Wind Direction/Mean/Gusts**		**Temp**	**Humidity %**	**Wind Direction/Mean/Gusts**	
6:00am	29.1	14	NE	17/24	26.9	24	NE	11/15
6:30	26.0	22	NNE	9/9	28.5	17	NE	13/20
7:00	26.3	20	N	9/13	29.9	15	NE	15/20
8:00	28.9	15	NE	17/22	31.9	14	NE	15/20
9:00	31.4	15	NE	13/17	32.2	13	NNE	9/20
10:00	34.9	9	N	13/22	35.6	11	N	13/18
11:00	37.5	8	N	18/30	38.7	12	NNW	20/32
12:00	40.4	7	NW	19/28	40.8	13	NNW	22/28
12.30	39.2	7	WNW	22/28	42.2	11	WNW	19/32
1:00	40.5	7	NW	24/33	40.7	11	W	22/35
1.30	40.0	6	WNW	20/28	ND	ND	ND	ND
2:00	40.0	7	WSW	18/26	41.1	15	WSW	17/24
2:10	40.9	6	W	15/20	ND	ND	ND	ND
2:30	40.0	7	WSW	19/23	40.7	14	SW	17/22
3:00	40.6	6	WSW	15/20	40.4	14	SSW	18/26
3:30	40.5	6	WSW	13/22	41.9	11	SSW	15/20
4:00	41.3	6	WNW	15/19	40.7	12	WSW	15/26
4:30	41.2	6	WSW	11/22	40.8	12	WSW	13/20
5:00	41.9	7	SW	9/15	41.1	13	SW	15/24
5:30	40.9	6	W	13/20	40.8	13	SSW	17/28
6:00	41.1	6	W	11/17	40.0	12	SSW	17/22
7:00	40.6	6	NW	9/15	37.9	21	SW	13/20
7:30	40.2	6	WNW	6/11	37.1	21	WSW	7/13
8:00	38.8	6	W	2/7	35.7	26	W	6/7
9:00	34.5	10	Calm	0/0	32.6	29	S	9/13
10:00	30.6	20	ENE	7/11	31.5	25	WSW	2/11
10:30	31.1	16	ENE	11/13	29.1	23	SSE	7/13
11:00	30.9	15	ENE	11/15	30.4	18	NNE	13/19
12:00	28.9	18	NE	11/13	31.2	14	E	17/24
4 dead; 1alive (7½ hours ≥40˚)					70 dead; 37 alive (6 hours ≥40˚)			
Colony Estimated at 10,500								

Data recorded from Adelaide's West Terrace Weather Station 1.2klms from colony

Adelaide data 2013 - 2019. The blocks of colour are consecutive days of high temperature.

DATE	COLONY	TEMP	DEAD	RESCUED	DURATION ≥ 40˚
19-12-13	1,000	43.3	21	2	7
13-01-14	1,000	42.1	Nil	Nil	3½
14-01-14	1,000	45.1	67	8	5
15-01-14	1,000	43.7	73	7	6
16-01-14	1,000	44.2	52	9	7
17-01-14	1,000	42.7	5	1	3
01-02-14	1,000	43.4	Nil	Nil	4
02-02-14	1,000	44.7	5	Nil	7
02-01-15	3,000	44.1	591	45	6 (high wind speed)
07-01-15	2,500	42.2	Nil	Nil	3
14-02-15	2,500	41.6	Nil	Nil	1
18-11-15	3,500	40.0	Nil	Nil	1
05-12-15	3,000	42.2	Nil	Nil	1
06-12-15	3,000	41.5	Nil	Nil	2
16-12-15	3,000	41.1	Nil	Nil	½
17-12-15	3,000	42.9	Nil	Nil	5
18-12-15	3,000	41.0	Nil	Nil	2
19-12-15	3,000	43.2	Nil	Nil	1½
25-12-16	7,500	41.1	Nil	Nil	1
07-01-17	7,500	40.5	Nil	Nil	1
08-02-17	8,000	42.4	84	2	5 (high humidity 1hr)
09-02-17	8,000	41.0	Nil	Nil	2
10-02-17	8,000	40.0	Nil	Nil	1
06-01-18	10,500	42.3	Nil	Nil	2½
18-01-18	10,500	41.9	4	1	7½
19-01-18	10,500	42.2	70	37	6 (rapid temp increase)
28-01-18	10,500	41.8	Nil	Nil	1½
27-12-18	17,500	42.1	Nil	Nil	2½
03-01-19	16,000	40.9	Nil	Nil	2
14-01-19	16,000	40.0	Nil	Nil	1
15-01-19	16,000	41.9	Nil	Nil	2
16-01-19	16,000	40.3	Nil	Nil	3½
23-01-19	16,000	40.9	Nil	Nil	1
24-01-19	16,000	46.6	4,000	106	8½ (5½ hrs≥45˚) low BCI
20-11-19	28,000	41.6	2,000	224	7 (strong hot winds)
17-12-19	26,000	42.1	Nil	Nil	1
18-12-19	26,000	43.7	2,000	100	7
19-12-19	26,000	45.3	4,000	185	8
20-12-19	26,000	43.9	2,000	100	6½

Sorted by Temperature

DATE	COLONY	TEMP	DEAD	RESCUED	DURATION ≥ 40˚
18-11-15	3,500	40.0	Nil	Nil	1
10-02-17	8,000	40.0	Nil	Nil	1
14-01-19	16,000	40.0	Nil	Nil	1
16-01-19	16,000	40.3	Nil	Nil	3½
07-01-17	7,500	40.5	Nil	Nil	1
03-01-19	16,000	40.9	Nil	Nil	2
23-01-19	16,000	40.9	Nil	Nil	1
09-02-17	8,000	41.0	Nil	Nil	2
18-12-15	3,000	41.0	Nil	Nil	2
25-12-16	7,500	41.1	Nil	Nil	1
16-12-15	3,000	41.1	Nil	Nil	½
06-12-15	3,000	41.5	Nil	Nil	2
14-02-15	2,500	41.6	Nil	Nil	1
20-11-19	28,000	41.6	2,000	224	7 (high hot wind speed)
28-01-18	10,500	41.8	Nil	Nil	1½
18-01-18	10,500	41.9	4	1	7½
15-01-19	16,000	41.9	Nil	Nil	2
13-01-14	1,000	42.1	Nil	Nil	3½
27-12-18	17,500	42.1	Nil	Nil	2½
17-12-19	26,000	42.1	Nil	Nil	1
07-01-15	2,500	42.2	Nil	Nil	3
05-12-15	3,000	42.2	Nil	Nil	1
19-01-18	10,500	42.2	70	37	6 (rapid temp increase)
06-01-18	10,500	42.3	Nil	Nil	2½
08-02-17	8,000	42.4	84	2	5 (high humidity 1hr)
17-01-14	1,000	42.7	5	1	3
17-12-15	3,000	42.9	Nil	Nil	5
19-12-15	3,000	43.2	Nil	Nil	1½
19-12-13	1,000	43.3	21	2	7
01-02-14	1,000	43.4	Nil	Nil	4
15-01-14	1,000	43.7	73	7	6
18-12-19	26,000	43.7	2,000	100	7
20-12-19	26,000	43.9	2,000	100	6½
02-01-15	3,000	44.1	591	45	6 (high wind speed)
16-01-14	1,000	44.2	52	9	7
02-02-14	1,000	44.7	5	Nil	7
14-01-14	1,000	45.1	67	8	5
19-12-19	26,000	45.3	4,000	185	8
24-01-19	16,000	46.6	4,000	106	8½ (5½ hrs≥45˚) low BCI

Sorted by Duration of Temperature in hours; ≥ 40˚

DATE	COLONY	TEMP	DEAD	RESCUED	DURATION ≥ 40˚
16-12-15	3,000	41.1	Nil	Nil	½
18-11-15	3,500	40.0	Nil	Nil	1
10-02-17	8,000	40.0	Nil	Nil	1
14-01-19	16,000	40.0	Nil	Nil	1
07-01-17	7,500	40.5	Nil	Nil	1
23-01-19	16,000	40.9	Nil	Nil	1
25-12-16	7,500	41.1	Nil	Nil	1
14-02-15	2,500	41.6	Nil	Nil	1
05-12-15	3,000	42.2	Nil	Nil	1
17-12-19	26,000	42.1	Nil	Nil	1
28-01-18	10,500	41.8	Nil	Nil	1½
19-12-15	3,000	43.2	Nil	Nil	1½
03-01-19	16,000	40.9	Nil	Nil	2
09-02-17	8,000	41.0	Nil	Nil	2
06-12-15	3,000	41.5	Nil	Nil	2
15-01-19	16,000	41.9	Nil	Nil	2
18-12-15	3,000	41.0	Nil	Nil	2
27-12-18	17,500	42.1	Nil	Nil	2½
06-01-18	10,500	42.3	Nil	Nil	2½
07-01-15	2,500	42.2	Nil	Nil	3
17-01-14	1,000	42.7	5	1	3
16-01-19	16,000	40.3	Nil	Nil	3½
13-01-14	1,000	42.1	Nil	Nil	3½
01-02-14	1,000	43.4	Nil	Nil	4
14-01-14	1,000	45.1	67	8	5
08-02-17	8,000	42.4	84	2	5 (high humidity 1hr)
17-12-15	3,000	42.9	Nil	Nil	5
19-01-18	10,500	42.2	70	37	6 (rapid temp increase)
15-01-14	1,000	43.7	73	7	6
02-01-15	3,000	44.1	591	45	6 (high wind speed)
20-12-19	26,000	43.9	2,000	100	6½
19-12-13	1,000	43.3	21	2	7
16-01-14	1,000	44.2	52	9	7
02-02-14	1,000	44.7	5	Nil	7
20-11-19	28,000	41.6	2,000	224	7 (strong hot winds)
18-12-19	26,000	43.7	2,000	100	7
18-01-18	10,500	41.9	4	1	7½
19-12-19	26,000	45.3	4,000	185	8
24-01-19	16,000	46.6	4,000	106	8½ (5½ hrs≥45˚) low BCI

Consecutive days of high temperatures with 2 days >42˚. No Deaths recorded. Combined data collected since 2002 indicates that it is not how many days but how high the temperature and how long the temperature remains high (duration). Also what other factors

Wednesday 16/12/15					Thursday 17/12/15				Friday 18/12/15				Saturday 19/12/15			
Time	Temp	Humidity %	Wind Direction/Mean/Gust		Temp	Humidity %	Wind Direction/Mean/Gust		Temp	Humidity %	Wind Direction/Mean/Gust		Temp	Humidity %	Wind Direction/Mean/Gust	
6:00am	24.8	37	WSW	4/7	25.0	41	Calm	0/0	23.8	56	Calm	0/6	30.4	26	NNE	7/11
7:00	24.2	46	WSW	6/7	25.4	44	Calm	0/0	24.7	63	N	6/7	31.2	26	ENE	6/9
8:00	27.3	41	SW	2/7	31.8	21	NE	7/15	27.3	51	NNE	7/13	34.1	20	NNE	9/15
9:00	31.3	31	WNW	7/11	34.9	15	NNE	11/19	30.0	42	W	6/11	37.5	15	NNE	11/18
10:00	33.8	25	WSW	6/9	37.3	12	NNE	13/22	33.0	30	SW	6/7	38.2	13	N	15/28
11:00	36.2	16	NNE	11/17	38.5	11	N	13/20	36.8	20	NNW	6/13	39.6	13	NNW	17/30
12:00	38.4	15	WSW	9/13	41.1	10	WNW	15/19	39.2	13	NNW	13/18	40.0	11	NNW	18/28
1:00	38.8	15	W	13/18	41.8	11	W	13/20	39.2	14	NW	13/20	40.6	13	NW	15/33
2:00	40.3	13	W	9/18	42.1	11	WNW	13/22	40.6	13	WNW	13/20	39.3	13	NW	13/26
2:30	41.1	12	WSW	15/24	42.2	10	W	13/22	41.0	13	WNW	13/20	41.8	12	WNW	13/15
3:00	40.4	13	WSW	15/20	42.7	10	NW	13/28	39.7	16	WSW	9/20	41.4	12	W	18/26
3.30	NA	NA	NA	NA	42.9	10	WNW	13/20	39.4	17	WSW	13/18	42.1	14	SW	13/22
4.00	40.1	13	W	13/22	42.1	11	W	15/24	39.4	17	WSW	13/18	43.2	12	WSW	13/22
5:00	39.0	13	WSW	13/18	40.8	12	WSW	17/30	39.9	17	SW	11/18	37.5	19	E	9/18
6:00	39.0	14	SW	13/18	38.0	15	WSW	15/24	39.0	17	W	11/19	37.0	20	ENE	7/17
7:00	37.8	15	WSW	13/20	38.0	17	WSW	11/17	38.4	19	WSW	9/15	37.9	18	E	2/9
8:00	34.8	21	SSE	11/22	35.8	21	SW	7/11	36.3	26	WSW	2/11	36.6	21	E	6/9
9:00	32.3	22	ESE	11/19	32.8	26	SW	7/9	33.2	22	E	11/26	34.5	28	Calm	0/7
10:00	31.7	23	ESE	11/20	31.3	29	S	4/7	32.8	23	NE	6/9	33.7	26	SSW	13/24
11:00	30.8	24	SE	9/18	29.8	34	Calm	0/0	31.8	30	N	4/7	32.5	27	SSW	15/26
12:00	30.5	24	ESE	13/28	28.6	37	Calm	0/0	30.6	29	W	2/7	29.7	40	SW	13/20
No Deaths (2 hours ≥40˚)					No Deaths (5hours ≥40˚)				No Deaths (½ hour ≥40˚)				No Deaths (1½ hours ≥40˚)			
Colony Estimate at 3000																

Behavioural observations: Flying-fox Colonies HSE

Date:_____ Name:_____ Phone:_____

Email:_____ Location:_____

Species:_____Temperature:_____

Please fill out as many cells below as you can. If you miss a time period, please leave the corresponding row blank and move on to the next one. Tick (√) if observed or cross (X) if not observed. Leave blank if not assessed.

Time	Wing fanning	Clustering	Panting	Licking wrists / wing membranes	Bats on ground	Bats dead	Comments / other observations (e.g. movements within and between trees, or towards water)
10:00							
10.30							
11.00							
11.30							
12.00							
12.30							
1.00							
1.30							
2.00							
2.30							
3.00							
3.30							
4.00							
4.30							
5.00							
5.30							
6.00							
6.30							
7.00							
7.30							
8.00							

Original Data Sheet Produced by Dr Justin Welbergen