Managing Heat Stress in Flying-foxes Colonies

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Table of Contents

Message from the Authors

Collectively the authors have been present at thirteen heat stress events from 1994-2013; ranging from severe (3500 deaths) to moderate (200 deaths); from Kyogle, Cabramatta and Emu Plains.

The one constant throughout a Heat Stress Event (HSE) is; bats will die. How many deaths will be determined by a number of contributing factors; these are listed on page 4.

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
- number of volunteers
- how accessible is the colony and
- what resources are available.

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

Our own encounters have demonstrated that when you are prepared for an event you can 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 Kyogle and Cabramatta Creek colonies; which collectively resulted in the deaths of some 7000 animals.

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
Heat Stress Events at Cabramatta 30/01/2003 and 01/01/2006, Emu Plains 14/01/2005.

Know Your Colony

Due to the number of factors that impact a Heat Stress Event (page 4) it is important that all colonies within your area are monitored regularly (once a fortnight) from November to February.

Monitoring the number of animals present, social structure, available food resources as well as the temperature provides a wealth of 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 orphaned young and injured adults; monitoring colonies can be difficult. However please consider; while you may save 100 orphans and injured flying-foxes 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.

What is a Heat Stress Event?

Heat Stress Events (HSE) in flying-fox colonies occur when temperatures within the colony reach 40ºC and above. 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 11.

What is Heat Stress?

The medical terminology for heat stress is hyperthermia, which 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 by a HSE;

- High temperatures 40ºC and above
- Animals access to adequate understory vegetation
- Birthing season: early - normal - late
- Time of the event: late December - early January-late January

Both these points will determined the age of the juveniles and their ability to cope.

- 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 there been temperatures of 40ºC plus within the past month (see temperature below)
  - Has the colony had an influx in numbers just prior to the HSE
- How accessible is the colony
- What resources are available to assist the animals.

NO TWO COLONIES ARE THE SAME; NO TWO HEAT STRESS EVENTS ARE THE SAME

However if we can get to the colony early and put a high percentage of our resources into keeping the bats cooler and hydrated; we can make a difference

Temperature

The temperature at which animals will begin to suffer the effects of heat stress will vary from colony to colony. While the temperature maybe high within the canopy it is the temperature of the understory that will ultimately determined the fate of the animals.

High temperatures will see flying-foxes seeking the coolest areas of the colony. For this reason it is important for each organisation responsible for a colony to be familiar with the changing conditions and climate within the colony they are monitoring.

It has often been considered that HSE occur when there are consecutive days of high temperatures. Looking at the history of HSE indicates that most events are the result of a single day of high temperatures (see tables pages 21 & 22). The one tragic exception being Singleton Nov/Dec 2003

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However, what has been a significant factor in some of the most severe HSE is the number of days within the month, but not consecutively, that temperatures were 40ºC plus. This greatly impacts on the condition of the animals and their ability to survive another day of soaring temperatures.

- Dallas Park 2002: Dec 25th 40.7ºC, Jan 2nd 40.2ºC, Jan 12th 42.9ºC.
- Cabramatta Creek 2003: Jan 18th 45ºC, Jan 30th 44.7ºC.

To date two key factors have emerged that help to elevate these devastating events
1. Adequate Understory vegetation and
2. Monitoring the temperature of the area in which a colony is located.

The Importance of Understory Vegetation

Most flying-fox colonies have ground covers and understory plants 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 the understory 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.

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 45ºC. With adequate understory and using a water tanker; no deaths were recorded. In 2013 temperatures reached 47ºC; 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 45ºC and 1700 animals died. The Ibis have since moved on and an extensive revegetated program undertaken. In contrast during the 2013 HSE temperatures reached 46ºC; however the temperature in the understory was again 3 - 4 degrees cooler; only 10 deaths were recorded and no animals removed.

Temperature Monitors

Most HSE in flying-fox colonies occur December/January, however Singleton 2003 recorded 44.1ºC November 30th. Unpredictable temperatures can occur at anytime; therefore it is recommended that two or three people should be nominated to monitor the temperature of the area in which the colony is located from November to February. There are a number of online weather sites that provide this information. Elders and Weatherzone both offer 7 - 10 day forecasts.

During the months November/February communication should be ongoing between Temperature Monitors and/or Flying-fox Coordinator/Colony 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 38ºC and over, with a predicted spike of 42ºC or over, 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.

Heat Stress Events 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

All 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 so the vaccinated carers can 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 nominated meeting point. These lists will vary from colony to colony & group to group however, a minimum list is provided in Appendix 1 page 19.

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

Colony Coordinator

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

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

The Colony Coordinator will be responsible for the welfare and organisation of the volunteers once they arrive. The Colony 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 Colony Coordinator will have a sign in sheet (see Appendix 3 page 23), and ensure volunteers complete all details before they enter the colony; and sign out when they leave.

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

The Colony Coordinator with be required to allocate areas or grids for the spraying teams.

Volunteers

On arrival volunteers must report to the Colony 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 Colony Coordinator. If a particular area has been assigned to you and you move out of this area without informing the Colony Coordinator; animals from that area may no longer be monitored.

Vaccinated Volunteers

Vaccinated volunteers primary responsibilities will be triage and spraying bats.

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

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 will require further observation; either during the spraying program, when the temperature drops and/or the following day.

When animals are entering Stage 2 (see page 12) 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 14) 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. A high percentage of animals that are brought into triage can be released back into the colony when the temperature drops.

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.

Heat stress events that have not been monitored from the onset will present with a much higher number of severely dehydrated animals.

Before you address dehydration; all flying-foxes entering triage need to have their surface temperature reduced and stress kept to an absolute minimum. Place the animals in the shade , in cages with hammocks and drape a damp (not soaking wet) towel over the cage. Animals can also be sprayed with tepid water.

The surface temperature must be reduced gradually. By lowing the flying-foxes ambient temperature the animals own thermoregulation responses can recover. This reduction in temperature usually occurs rapidly; monitor the animals closely as they can chill quickly. We recommend allocating specific carers to monitor this process.

Once the animals temperature has been reduced you can now address dehydration. You will find that a high percentage of animals will now respond to oral fluids.

Most of the animals that are brought into triage should be returned to the colony when the temperature drops late afternoon.

Tips for Keeping Spray Water Tepid

When filling your large on site water containers add a couple of jugs of boiled water; this will take the chill off the water. When you arrive at the colony keep your water containers in the sun.

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.

10.00am

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

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.

For those colonies using pumps (see page 10) this would be the time to organise.

1.00pm

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 an allocated an area of responsibility within the colony.

2.00pm to 3.00pm

Volunteers should move amongst the animals in the colony quietly & keep movements to a minimum and 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 HSE your efforts to assist may lead to increased mortality.

Equipment for Spraying the Colony & Flying-Foxes

Water tankers have been successfully used at Emu Plains & Cabramatta Creek colonies.

Equipment supplied by Fairfield & Liverpool Councils and Boral

Pumps have been used at Cabramatta

When using a pump the foliage is sprayed not the bats

These sprayers to date have been the 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
- They have a handle and a shoulder trap

STAGE 1

The timing of each stage is a GUIDE ONLY

Time frame for Stage 1: Approximately 10.00am to 12.00pm

Normal Roosting Position

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

They begin to fan themselves and move lower down in the trees to escape direct sunlight.

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; causing them further stress.

Continue observations

STAGE 2

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

When temperatures reach approximately 40ºC flying-foxes will move lower down the trees into the understory foliage and to ground level.

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

- shaded side of the trees
- the understory
- the base of trees
- under logs (see page 15)
- 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 dehydrated and will have difficulty managing their own 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 and sprayed using equipment that can deliver a mist from a minimum distance of 1-2metres.

Ideal equipment for long distance spraying

STAGE 2 cont:

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 on how quickly these animals can respond; no animals were taken in 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

Panting

The animals in the left hand photo should respond to spraying.

Clustering

For the animals on the right it may still be too early if so return later

Some animals will begin experiencing the above symptoms during stage 2 most will begin Stage 3.

STAGE 3

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

When temperatures reach approximately 42º C - 44º C, the flying-foxes are now severely heat effected and need cooling/fluids. Without help they will begin to die

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 misting/spraying in earnest. If you spray while you slowly approach the animals they will immediately start licking the water and won't care how close you are.

The number of volunteers available will determined 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 will be found throughout the colony. When this photo was first viewed by a carer they thought this group were dead and dying. They are in fact; actively licking water and very responsive. The spray gun can be seen in the left hand corner. 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:

Clumps can contain as many as 50 animals (photo below). The heat build-up inside these clumps can be extreme. The flying-foxes that are on the bottom or in the middle can die from the excess heat within the clump. 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

There were approximately 50 bats under these logs. By spraying the animals you can see on both sides of the log; you can get them to move out & up so you can now reach the animals underneath.

If you look closely at the eyes of the animals in this photo you will see the difference.

Although the bat on the right is panting it did respond to spraying and survived; the bat on left did not.

As she was a banded female we were later able to determined she was quite old.

This female was not the mother of the juvenile on the right.

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. This separation behaviour can also be seen in colonies through the months of January to March and is also observed between captive females and their young. During the day mothers leave their young often for many hours and then return.

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

There are no dead or dying animals within this cluster

We know from past heat stress events that 70-80% of deaths can be juveniles; so the remaining 20-30% will be made up of; males-lactating females-non lactating females and geriatrics. Therefore it is safe to conclude that most surviving juveniles will still have mothers alive within the colony.

There have been HSE 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 47ºC. The temperature in the understory was 42ºC-44ºC. 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.* Only 3 juveniles were removed during this HSE.

Juveniles cont:

During the Cabramatta HSE of January 2003 temperatures reached 45ºC; 1700 animals died. However, only 25 juveniles were permanently removed and taken into care. The colony was checked for a number of days after the event; only 2 dehydrated adults were found.

The two young juveniles in the photos below were also 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.

There are a number of things to consider when faced with such overwhelming numbers of juveniles;

- is it natural instinct that separates juveniles from their mothers?
- are they instructed to do this by their mothers?
- is it a combination of both?
- none of the above?

We may never know the answers to these questions; but what we do know is; given the opportunity these clusters of juveniles, when they return to the canopy, will reunite with their mothers.

There are juveniles that do need to come into care;

1. Those found attached to dead mothers.
2. Those not responding to on site fluid therapies.

Although during the course of a HSE a number of juveniles (and adults) will be brought into triage for rehydration; only those juveniles from the 2 points above need to remain in care. In the late afternoon when the temperature drops and having been successfully rehydrated these animals can be released back to the area they were found. Trees to be tagged and checked over the following days.

Animals die during heat stress events; most 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.

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.

This is the same area 3 hours earlier; 3.00pm

Disposing of Bodies

Where possible after a HSE the bodies should be processed and the number of deaths, sex, age, weights and forearms documented. Also check dead bats for bands, tracking aerials and collars.

This information can be extremely beneficial for future events in your colonies. We used this data along with temperatures, number of animals in the colony and Sonya's photographic documentation to better understand the heat stress events of both Cabramatta and Emu Plains. Also our response to these event significantly impacted on the outcome.

This data also highlights the impact natural disasters can have on population numbers especially when added to the many other hardships these animals encounter both natural and manmade.

If the number of deaths is high and where practicable the disposing 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. Gardening 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.
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 maybe 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 made contact with the Colony Coordinator and completed the sign on sheet.
3. All volunteers working in the colony must work in pairs.
4. Volunteers should not deviate from instruction without consulting the Colony 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 Colony 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 & Colony Coordinators

1. First Aid Kit
2. Volunteer Registration Sheets
3. Animal Registration Sheets
4. Soap + 2 Buckets (for washing hands if bitten or scratched)
5. Spraying Equipment
6. Water Containers to fill the spray bottles and pumps
7. Flagging Tape; multiple colours (for marking trees & cages)
8. Lectade
9. Hartmans + Needles
10. Hazard Waste Container
11. Body Bags
12. Face Masks + Vicks (when collecting dead bodies this will helps with the smell)
13. Pegs (have a multitude of functions)
14. Safety Vests
15. Latex Gloves
16. 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:

Temperatures from Two Sydney Colonies Resulting in a Heat Stress Event

CABRAMATTA CREEK COLONY				
	2003	2006	2007	2013
	Jan	Dec/Jan	Jan	Jan
30th		36.8		
31st		37.0		
1st	22.0	44.0	24.5	32.2
2nd	26.8	22.5	25.3	24.9
3rd	27.1	33.8	24.2	27.9
4th	28.0	20.8	26.5	32.9
5th	29.3	21.2	28.8	35.0
6th	30.8	27.5	34.0	32.6
7th	31.0	25.8	28.4	30.8
8th	38.5	28.0	25.5	
9th	25.3	28.6	25.8	40.2
10th	26.4	33.0	30.0	
11th	24.3	35.9	37.7	36.9
12th	25.0	28.0	35.7	
13th	27.4	27.0	28.0	34.2
14th	28.1	34.5	27.4	24.8
15th	28.2	24.7	28.5	
16th	30.0	28.6	30.6	33.4
17th	34.2	28.4	35.0	33.4
18th	45.0	22.7	31.1	45.6
19th	28.4	23.5	31.5	
20th	31.5	27.5	38.1	
21st	39.9	34.8	41.4	
22nd	24.2	33.7	31.5	35.0
23th	25.6	35.5	32.1	
24th	30.2	26.5	27.0	31.2
25th	34.5	22.2	24.9	
26th	41.3	28.6	32.0	
27th	29.2	33.6	34.5	22.9
28th	28.8	30.6	31.5	
29th	31.7	30.5	29.3	
30th	44.7	32.8	35.5	
31st	32.3	25.1	28.7	32.8

EMU PLAINS COLONY					
	2003	2005	2006	2007	2013
	Jan	Jan	Dec/Jan	Jan	Dec/Jan
30th			39.0		26.9
31st			40.1		36.5
1st	22.9	36.0	44.4	22.1	40.7
2nd	28.7	31.5	22.3	26.4	27.5
3rd	29.6	31.9	35.5	25.7	29.3
4th	30.7	31.5	19.9	27.9	35.7
5th	31.8	32.8	20.8	31.8	39.6
6th	33.5	32.9	28.4	35.4	35.7
7th	34.2	28.7	26.0	28.9	34.0
8th	41.2	26.0	28.8	26.2	42.0
9th	26.7	24.8	29.9	27.7	27.6
10th	27.1	27.5	34.3	33.3	26.9
11th	24.5	30.1	38.7	40.2	40.0
12th	26.3	39.2		40.9	38.6
13th	27.5	40.9	23.0	29.5	25.1
14th	30.5	44.3	34.2	30.0	25.7
15th	31.0	33.9	24.3	31.5	29.0
16th	32.0	34.8	28.1	32.8	35.8
17th	38.8	21.2	27.2	37.6	36.0
18th	44.5	24.2	20.8	34.8	46.5
19th	31.1	31.7	24.6	35.4	26.2
20th	33.9	38.0	27.2	40.6	24.8
21st	42.5	33.2	35.4	41.6	30.5
22nd	24.1	30.6	36.3	33.6	33.1
23th	25.4	22.7	37.1	35.0	26.6
24th	32.6	27.9	27.2	27.0	31.5
25th	38.2	27.6	21.9	25.5	35.3
26th	42.3	29.5	29.5	33.8	33.0
27th	32.5	29.1	35.9	34.8	23.6
28th	28.9	30.6	32.5	32.3	23.1
29th	36.1	32.8	32.3	31.0	28.1
30th	45.0	26.5	34.6	38.8	28.0
31st	34.8	29.3	27.4	30.4	34.8

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It has often been reported that HSE occur when there are consecutive days of high temperature. Looking at the history of HSE indicates that most events are the result of a single day of high temperatures.

Emu Plains is the only exception; yet this colony has the lowest percentage of deaths occurring. Fortunately for this colony it has an extremely dense understory.

Temperatures from Numerous Colonies Resulting in a Heat Stress Event

	Dallas Park	Bellingen	Bomaderry	Sydney	Parramatta
	2002	2002	2013	2013	2013
	Dec/Jan	Dec/Jan	Jan	Jan	Jan
30th	36.8	34.0			
31st	33.0	32.8			
1st	34.9	38.9	29.9	26.2	33.2
2nd	40.2	40.2	20.1	22.9	25.0
3rd	32.4	27.3	25.8	24.8	27.3
4th	31.1	27.6	30.6	26.6	31.8
5th	30.7	29.6	34.4	28.3	36.5
6th	33.2	27.2		28.0	31.8
7th	34.2	31.7		27.5	31.0
8th	37.3	31.7	42.4	42.3	41.3
9th	34.2	26.9	23.7	25.0	24.0
10th	30.9	26.1	26.2	25.4	25.5
11th	30.5	28.8	33.4	29.6	35.3
12th	42.9	43.3	29.5	31.2	32.5
13th	30.7	25.2	22.0	23.8	24.5
14th	28.5	26.0	23.1	23.7	23.5
15th	29.3	25.6	24.9	24.9	26.0
16th	31.2	23.6	29.5	27.2	32.5
17th	27.7	24.2	33.9	29.0	31.2
18th	29.0	24.7	45.4	45.8	45.5
19th	29.7	25.4	20.3	24.8	25.1
20th	30.2	27.0	24.9	24.3	24.0
21st	30.3	27.8	28.9	26.6	28.2
22nd	31.7	27.8	34.8	29.6	35.2
23th	30.8	27.7	23.0	25.7	25.5
24th	31.6	26.5	30.2	29.8	29.8
25th	30.0	26.7	32.3	29.2	32.0
26th	29.7	26.7	30.2	28.2	30.7
27th	30.6	27.2	27.6	22.7	22.2
28th	30.7	27.7	22.0	23.0	22.8
29th	30.6	27.2	25.9	26.2	27.0
30th	28.9	27.2	23.6	26.0	27.0
31st	29.9	27.3	30.3	27.8	31.8

Singleton	
	2003
	Nov/Dec
29th	31.0
30th	44.1
1st	44.8
2nd	22.8
3rd	24.9
4th	26.5
5th	27.6
6th	30.0
7th	27.5
8th	32.1
9th	31.8
10th	26.0
11th	32.6
12th	32.0
13th	30.8
14th	31.5
15th	26.0
16th	30.6
17th	28.5
18th	28.9
19th	36.9
20th	26.5
21st	30.7
22nd	37.0
23th	35.3
24th	36.8
25th	25.7
26th	26.7
27th	32.2
28th	24.6
29th	24.1
30th	25.0
31st	29.0

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Dallas Park	
	2002
	Dec
24th	38.5
25th	40.7
26th	38.2

Twenty six days of 40ºC plus are recorded in the tables on pages 20&21; however only 7 have recorded a temperature of 38ºC or over the day prior to the HSE. Most temperatures on the day prior to the HSE were in the high 20's to mid 30's

Singleton has recorded the highest and most devastating consecutive days. Emu Plains is the only other colony to record 40ºC plus on consecutive days.

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 instructions given to you by the Colony Coordinator

ORANISATION BRANCH	NAME	PHONE HOME - MOBILE	ADDRESS	VACCINATED YES / NO	TIME IN	TIME OUT
		H				
		M				
		H				
		M				
		H				
		M				
		H				
		M				
		H				
		M				
		H				
		M				
		H				
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		M				
		H				
		M				
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		H				
		M				

Appendix 5:

Observing the impacts of extreme temperature events on flying-foxes: recording protocols and explanation of data sheets

Contact: Justin Welbergen

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First things first
Visiting a flying-fox camp during an extreme heat event can be very stressful for you and the bats, and we do not want our observations to add to this. Therefore, please do not go in unless you had decided to go in anyway, for example because you are a bat carer who wants to help mitigate the expected impacts of the extreme heat. Also, be aware that not all camps have legal public access, in which case you need to obtain permission from the land manager.

Your health and safety
If you do decide to go, please take care of yourself. Be aware of the latest bushfire information. Take the usual precautions for hot weather including staying in the shade, bringing water and sun protection. Also, do not touch any bats (alive or dead) unless you know what you are doing, you wear latex gloves, and your pre-exposure Lyssa virus vaccination is up-to-date.

Health and safety of the bats
Be aware that by your presence you can be disturbing the bats (which is illegal) and on a very hot day this can increase mortality. Therefore, if you feel that your presence is causing problems for the bats (for example, causing the bats to fly off from their roost) then please stop what you are doing and back away from the camp.

Please realise that if you decide to help with our observations, you do this on your own account, as we cannot be responsible for your actions.

The next page provides an explanation of the spreadsheets and the kinds of data that we would like you to help collect. The subsequent two pages contain the relevant spreadsheets for easy data entry.

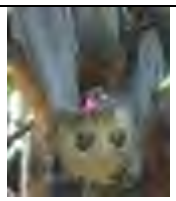
Sheet 1: Behavioural observations

These data will allow us to determine how the flying-foxes vary their behaviour during the day in response to rising ambient temperatures. The data sheet is set out so that each row corresponds to a different time point during the day. For each time point, check the bats for the behaviours/states indicated in each column (including wing fanning, clustering, on the ground etc, see below). If you see bats performing any of the behaviours, tick that box in the row. For example, if at 10:30 you see some bats fanning their wings and some licking their wrists, but none of any of the other behaviours, then go to row 10:30 and tick (✓) the boxes "wing fanning" and "licking" and put a cross (X) in all the other boxes. The idea is to record a "snapshot" at each time point. You are very welcome to record additional observations in the comments section, for example information on movements within or between trees, or anything else that seems relevant.

If you can only visit a camp for a short period, your data is still very important. Just begin at the row that corresponds to the time you start watching the bats.

We would like any data you are able to collect but the data sheet is the most important. However, photos and/or video footage of the bats are always extremely useful, particularly when these are time-stamped.

Definitions of behaviours/states mentioned in sheet 1

Wing fanning	**Clustering**	**Panting**	**Licking wrists/wing membranes**	**Bats on ground**	**Bats dead**
Movement of wings in steady fanning motion	Individuals moving in very close proximity of each other, forming "balls of bats"	Rapid breathing with mouth open	Individuals licking their wrists or wing membranes	Individuals on the ground, lethargic but still alive	Dead individuals, on the ground or in the trees, or both
					

Sheet 2: Post mortem measurements

These data will allow us to assess the 'body condition' of the bats that died. For this, we need you to measure forearm length (to the nearest mm, if possible) and the weight (to the nearest gram, if possible) of a sample of bats that have died (if any). For your own safety, please do not collect these data unless your pre-exposure Lyssa virus vaccination is up-to-date and you are wearing latex gloves. The measurements should be taken as soon as possible after death to account for post-mortem changes in weight.

Sheet 3: Mortality data

These data will allow us to determine who died. If you still feel up to it at this stage, and you are able to separate species by sex and age class, please fill out the table with the numbers of bats that died (if any) in each category. This can be done late in the day or during the next morning.

Date:		**Name:**		**Phone:**	**Email:**
Location:					

Estimated number of bats present:	
(proportion greys):	
(blacks):	
(little reds):	
Estimated number of bats died (if any):	

Please send a copy of the sheet to:
Dr Justin A. Welbergen (justin.welbergen@jcu.edu.au)
Centre for Tropical Biodiversity & Climate Change
James Cook University
Townsville, Qld 4814
(Ph: 07 4781 4479; Mob: 0457 338 189)

SHEET 1: 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 / other observations (e.g. movements within and between trees, or towards water)
10:00							
10:15							
10:30							
10:45							
11:00							
11:15							
11:30							
11:45							
12:00							
12:15							
12:30							
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15:45							
16:00							
16:15							
16:30							
16:45							
17:00							
17:15							
17:30							
17:45							
18:00							

SHEET 2: Post-mortem measurements

If you are up to it, are qualified and have taken appropriate safety precautions, please provide the species, sex, forearm length and weight of (a sample of) the individuals that died. This should be done soon after death to account for post-mortem changes in weight.

Species **B - GH - LR**	**Sex** **M - F**	**Forearm** **mm**	**Weight** **grams**	**Comments**

SHEET 3: Mortality data

If you are able to separate species by sex and age class, please fill out the table with the numbers of bats that died (if any) in each category. If you feel you cannot confidently separate the species by age and/or by sex then the total numbers for each sex or each species still provides very important information. These mortality data can be collected late in the day or during the next morning.

	Black	**Grey-headed**	**Little reds**
TOTAL FEMALES:			
Juvenile *females* (<1 year)			
Subadult *females* (1-2 years)			
Adult *females* (2 years+)			
TOTAL MALES:			
Juvenile *males* (<1 year)			
Subadult *males* (1-3 years)			
Adult *males* (3 years+)			
TOTAL DIED:			