

Flying-foxes and extreme heat events: impacts and responses

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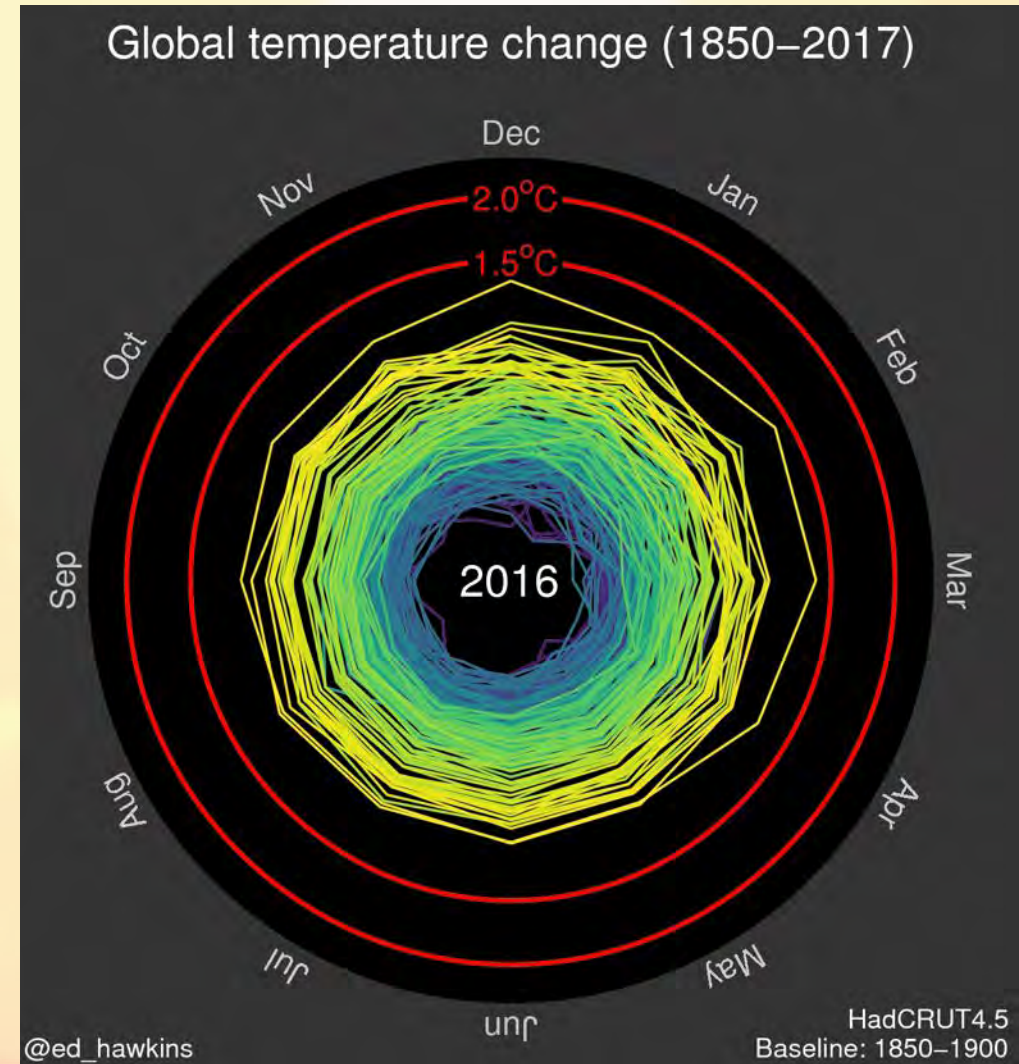


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Zoology

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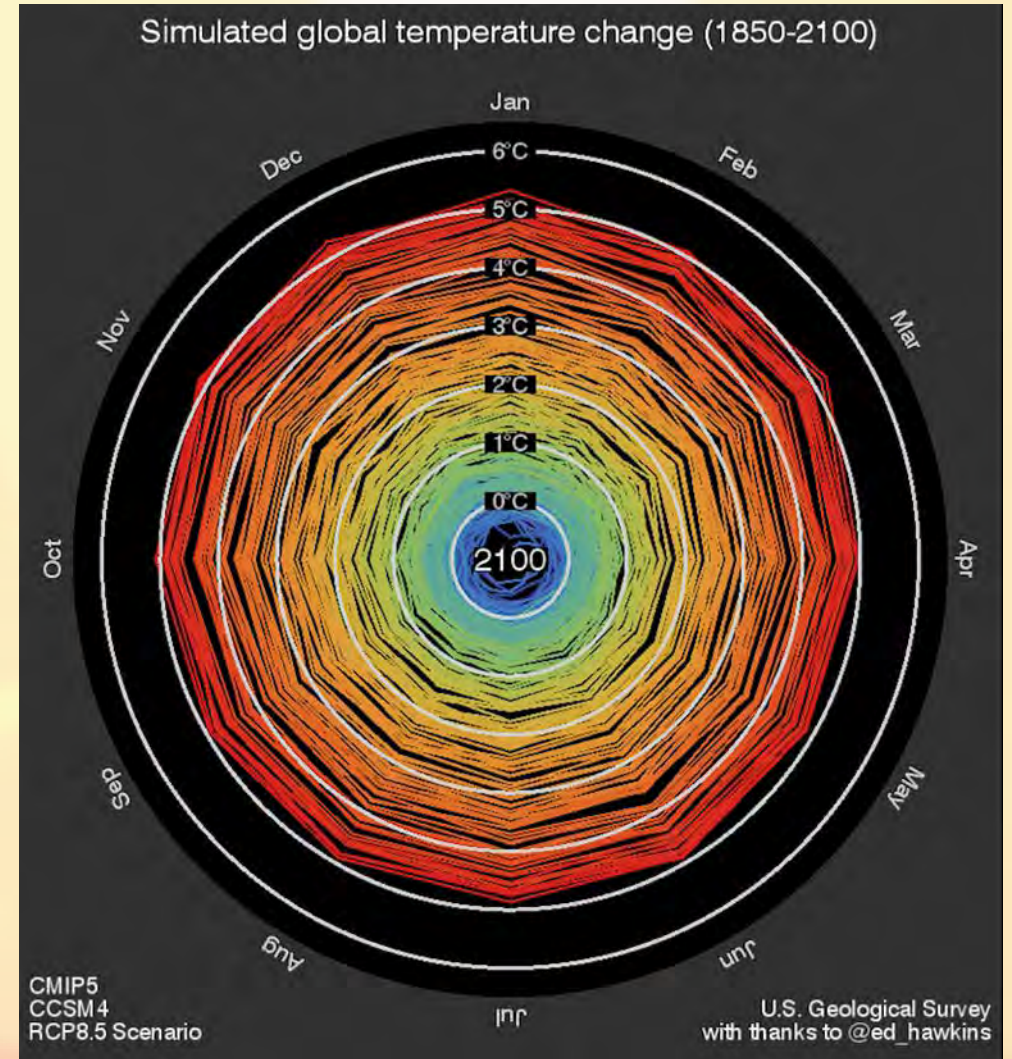
Our world is warming

The instrumental record shows a clear upward trends in global land and ocean temperatures since the early 20th century

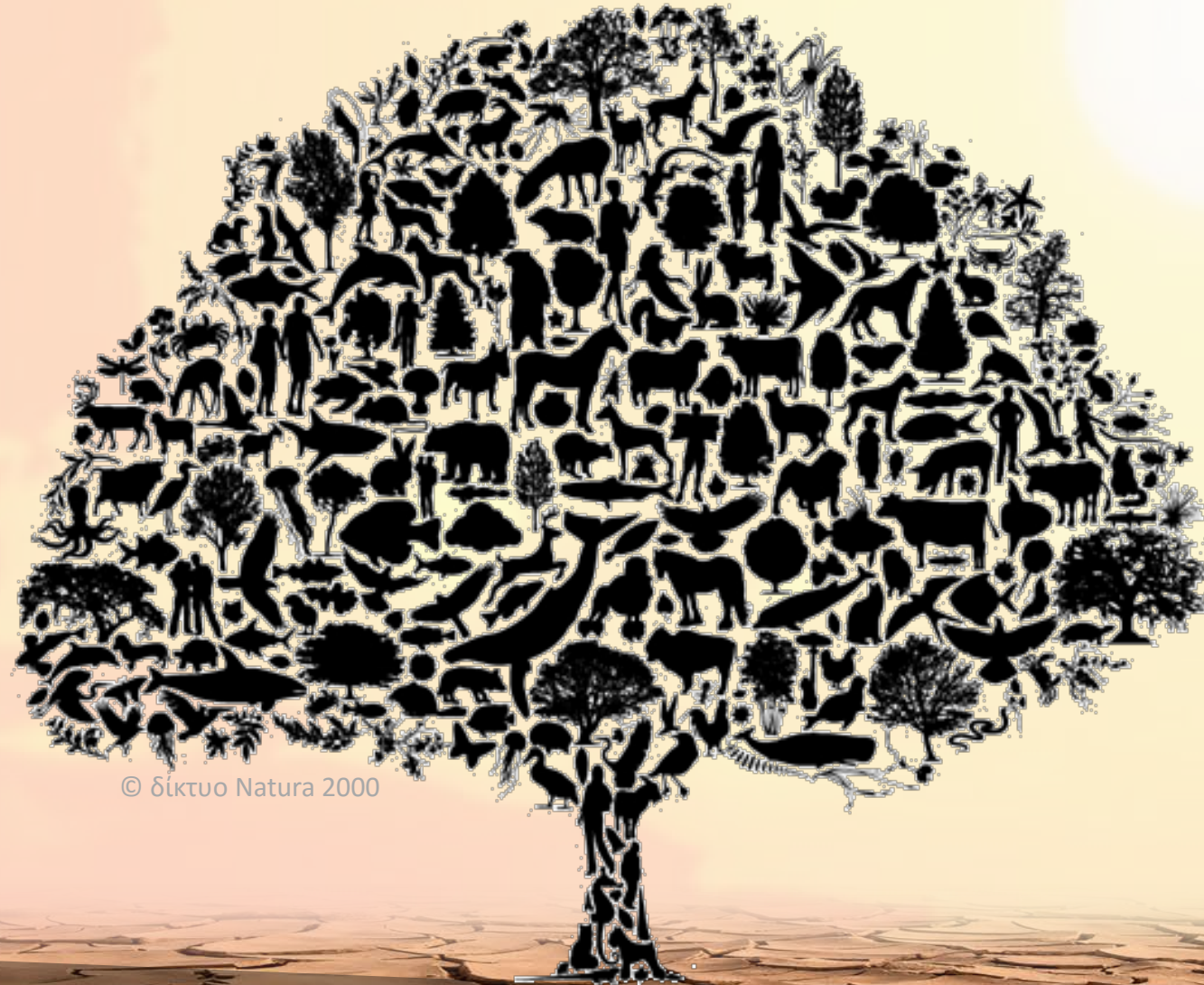


Our world is warming

These upward trends are expected to escalate into the 21st century



What are the impacts of extreme heat events on biodiversity?



© δίκτυο Natura 2000

Impacts of extreme heat events on flying-foxes, *Pteropus* spp.

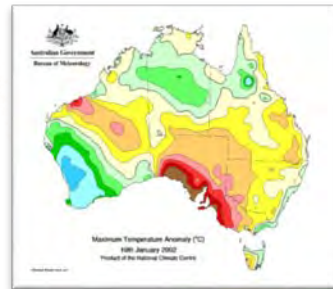




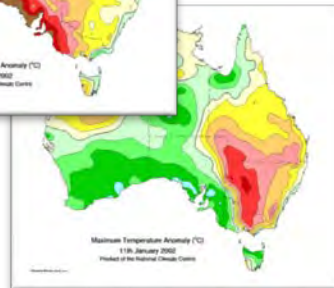
Welbergen, J.A. 2005. The social organisation of the grey-headed flying-fox, *Pteropus poliocephalus* (PhD thesis, University of Cambridge)

2002 Northern NSW extreme heat event

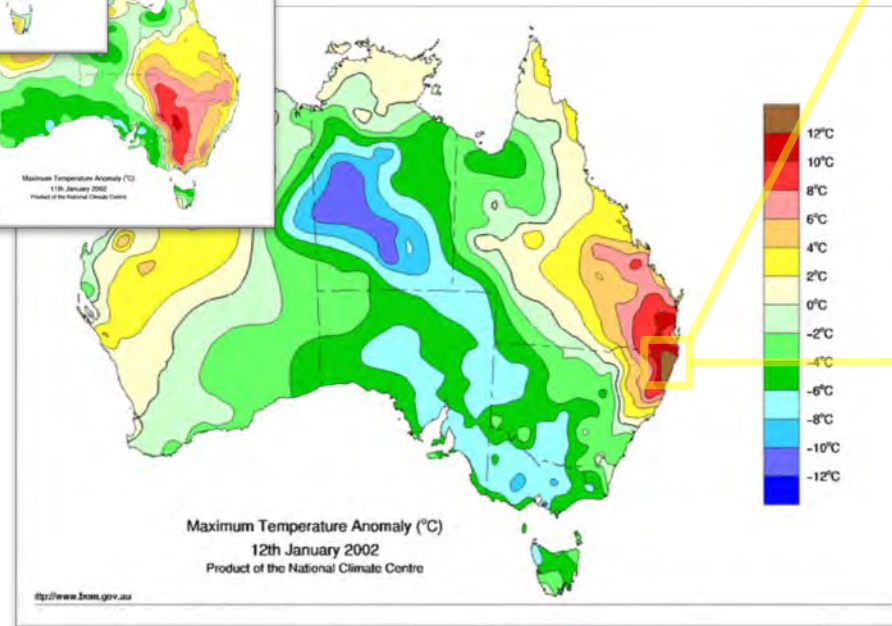
Jan 10th:



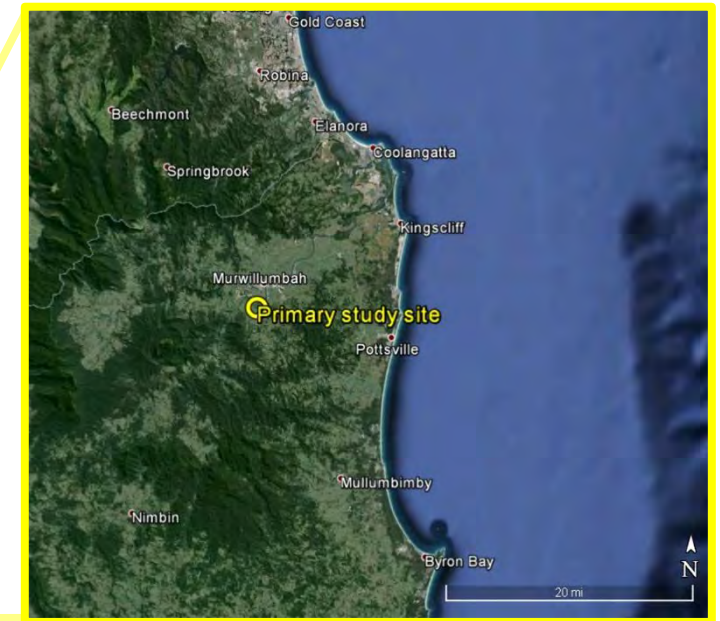
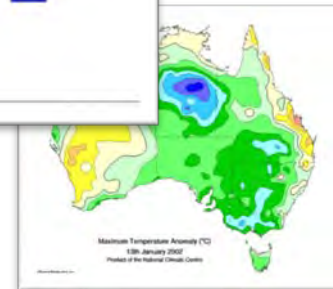
Jan 11th:



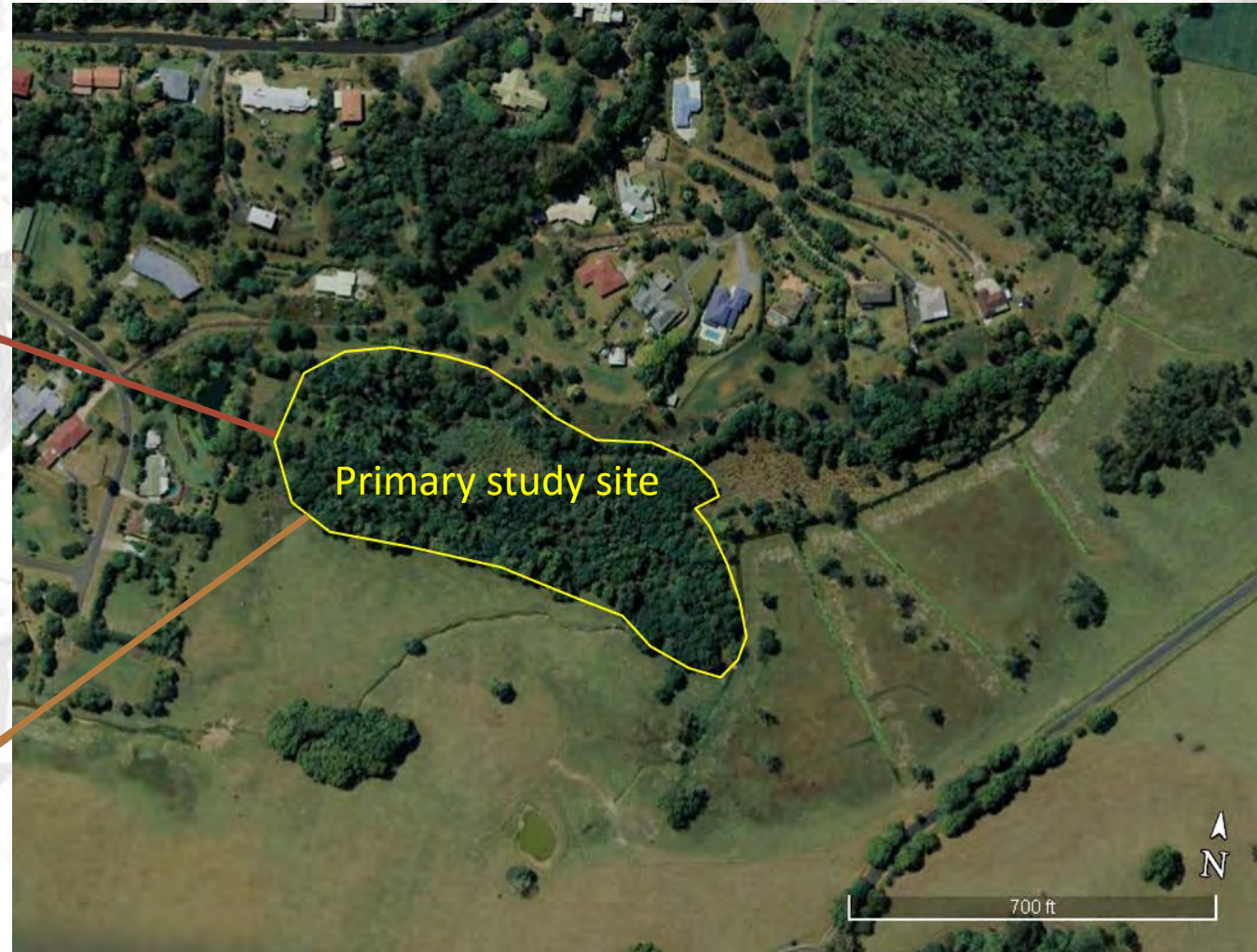
Jan 12th:



Jan 13th:



Study site contained two species: the black flying-fox and the grey-headed flying-fox



.. with similar 'slow-lane' life-histories and food preferences

Black flying-fox

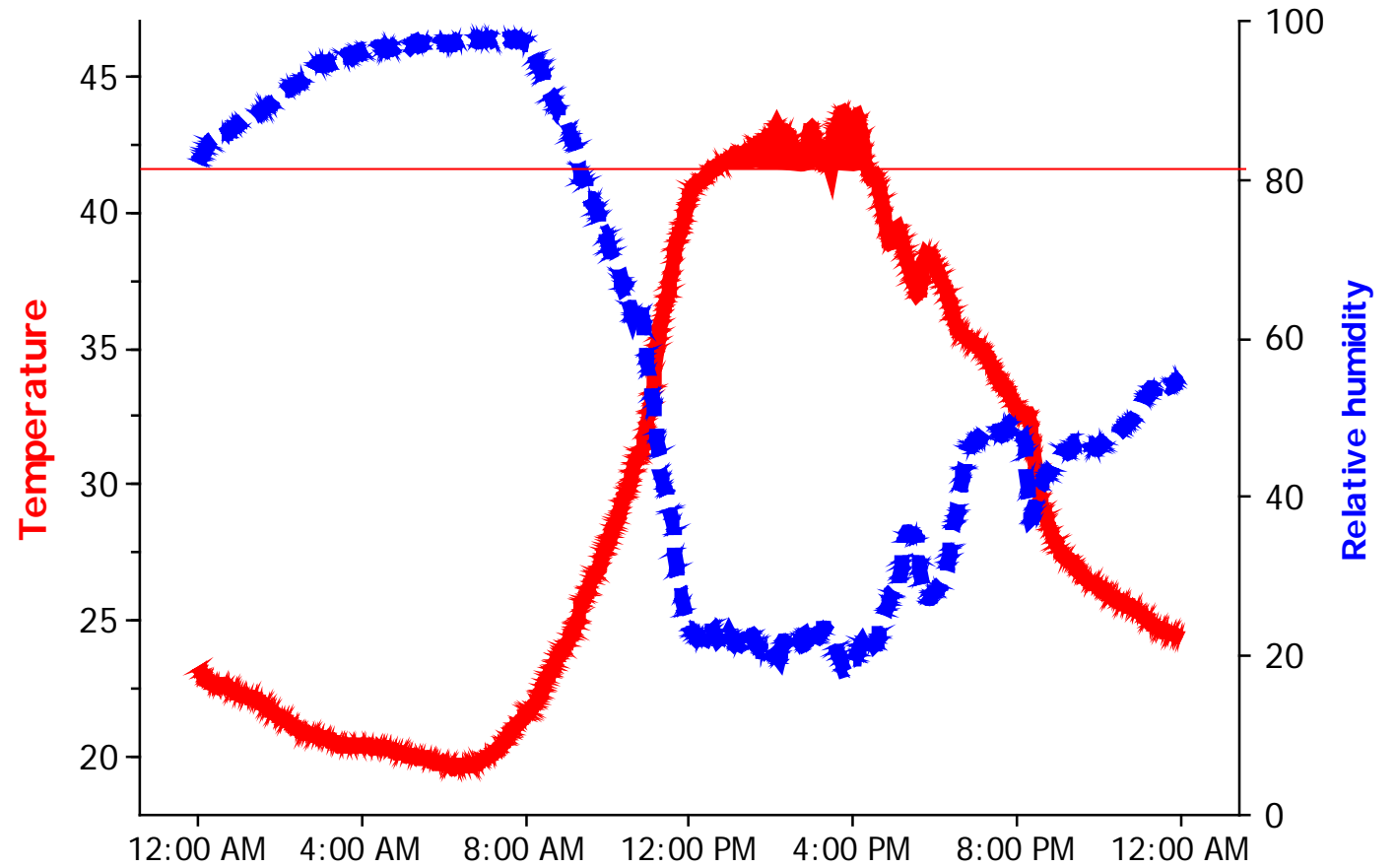
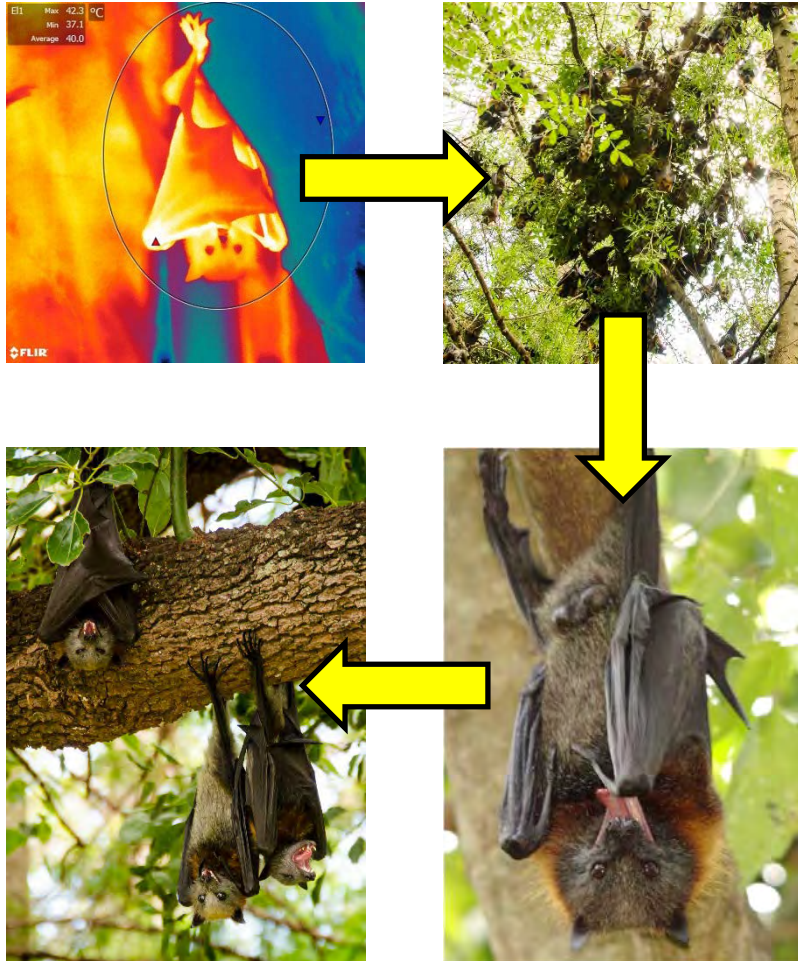


Grey-headed flying-fox

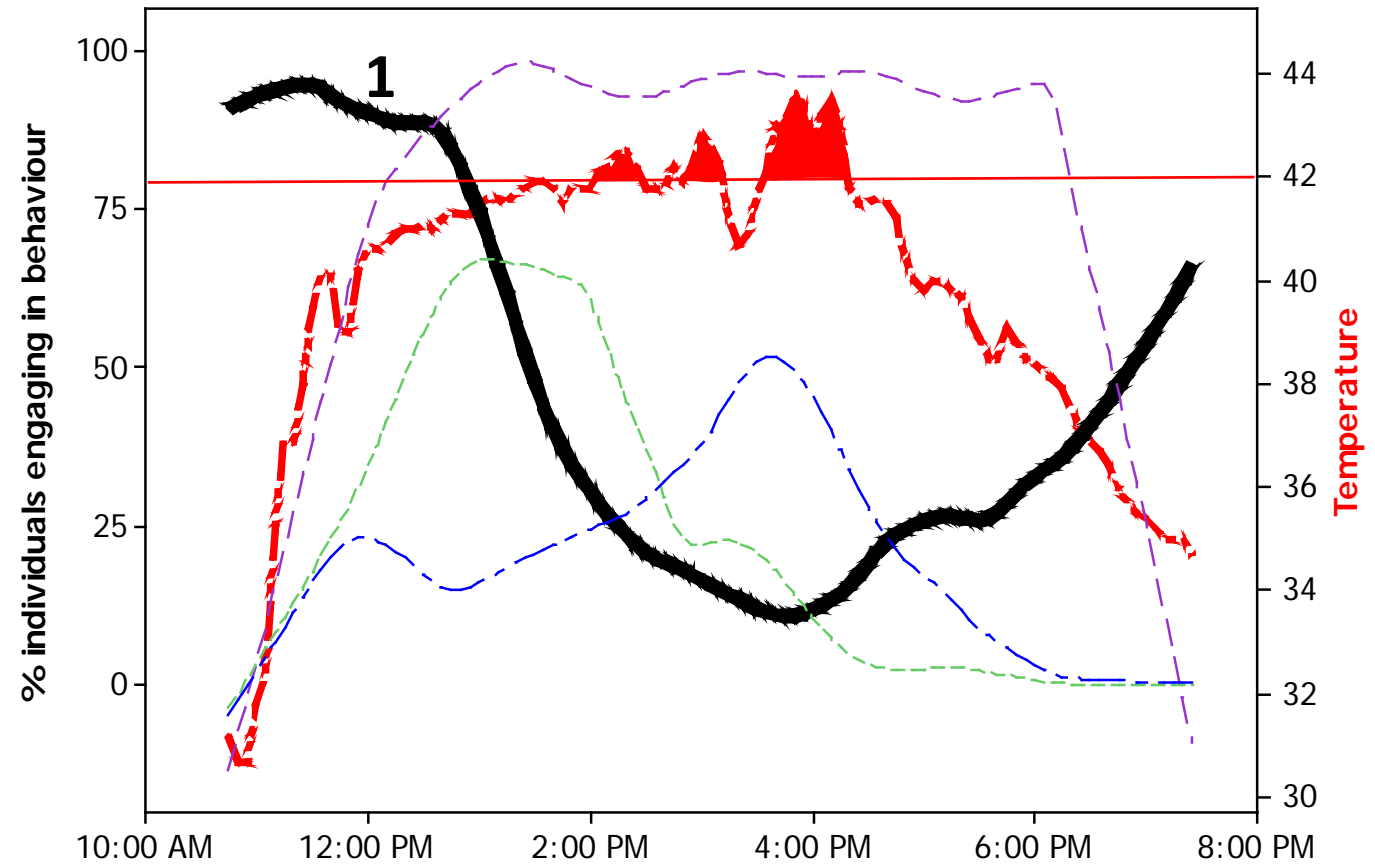
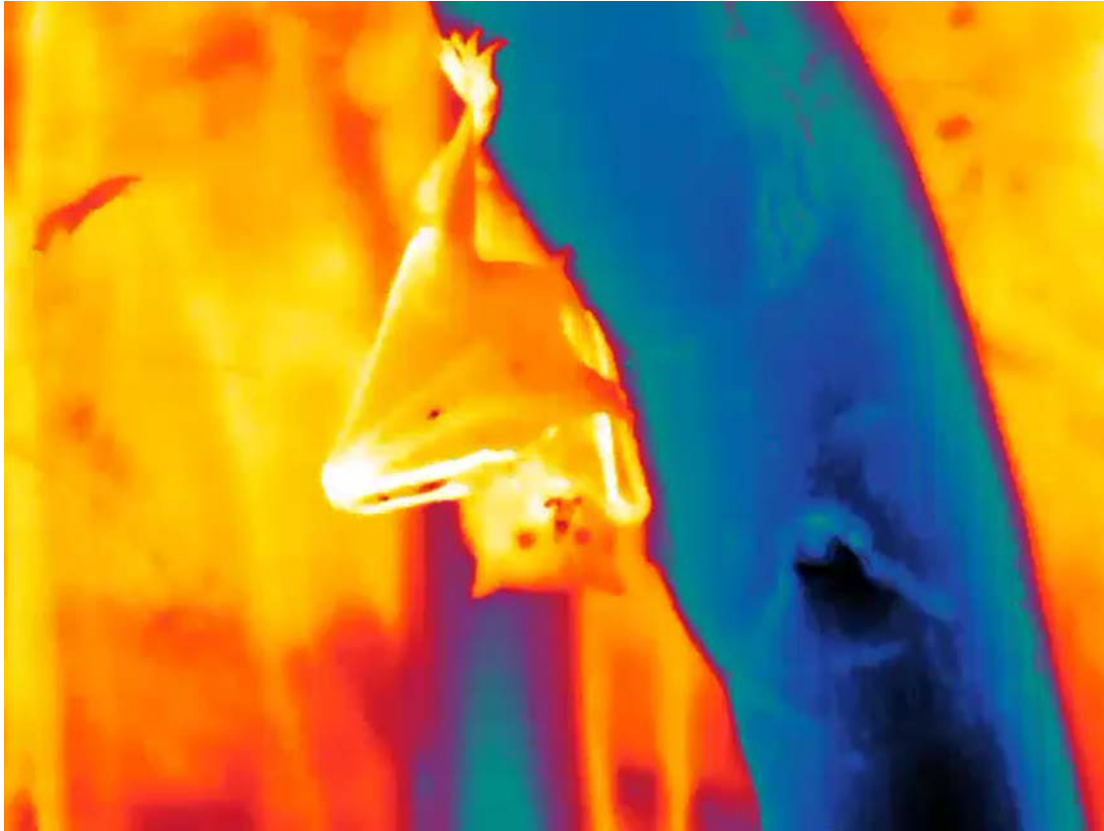


- Adult weight: 600-1100 g
- Wingspan: 1.2 - 1.6 m
- Number of young: 1/year
- Time to mature: 18-36 months
- Maximum age: 15-21 years
- Food: nectar, pollen, fruit

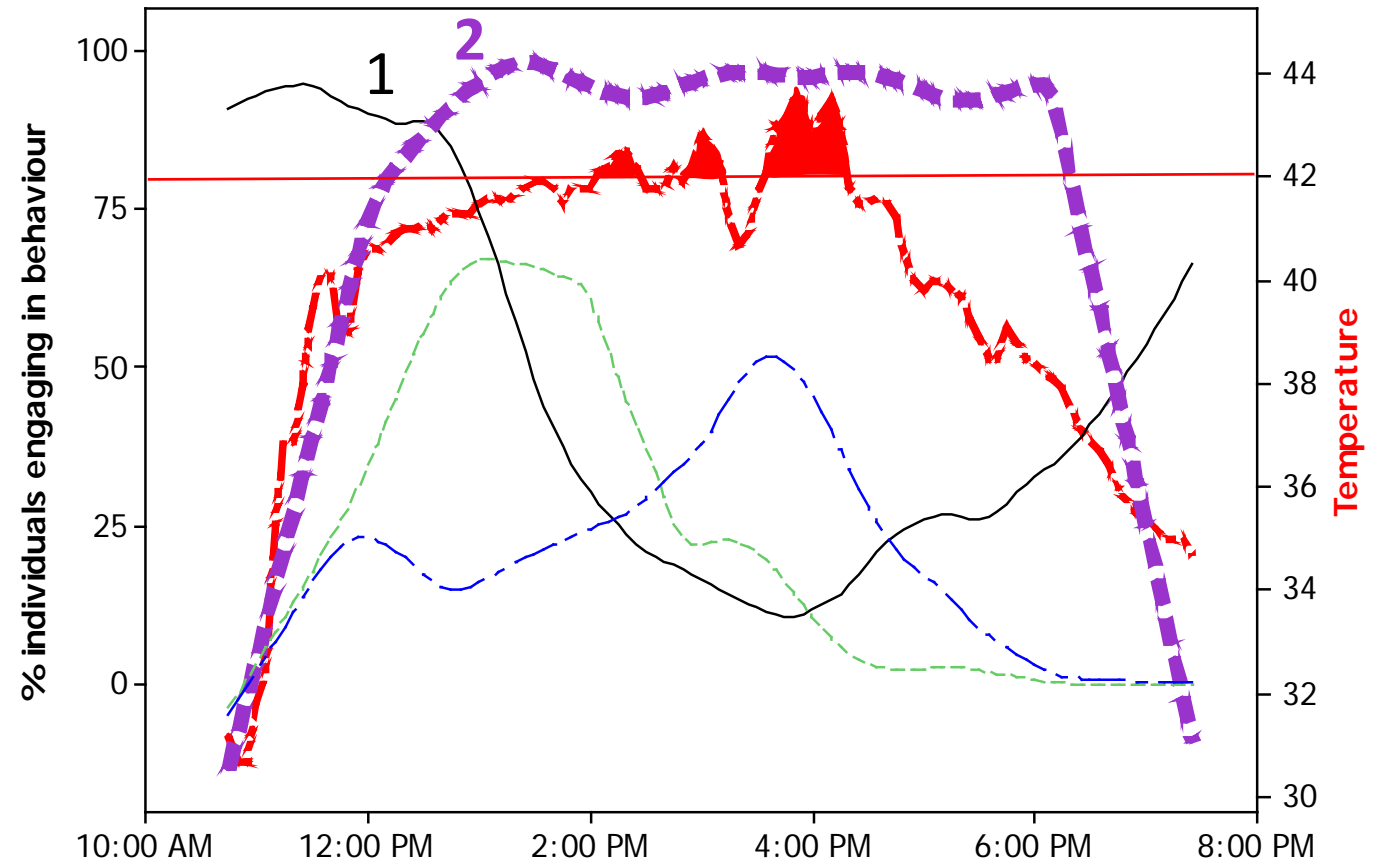
Flying-foxes show a predictable sequence of thermoregulatory behaviours



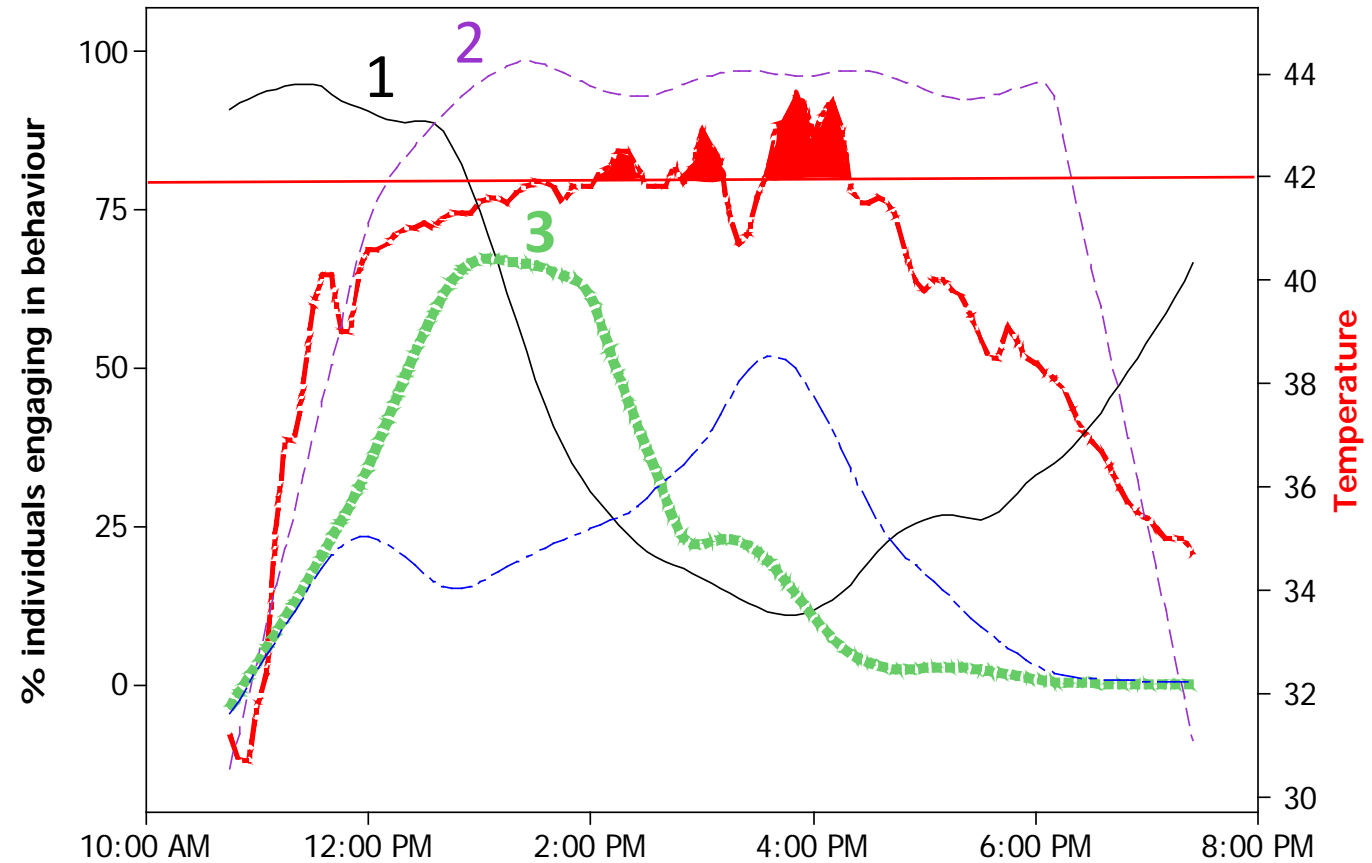
1. Wing fanning



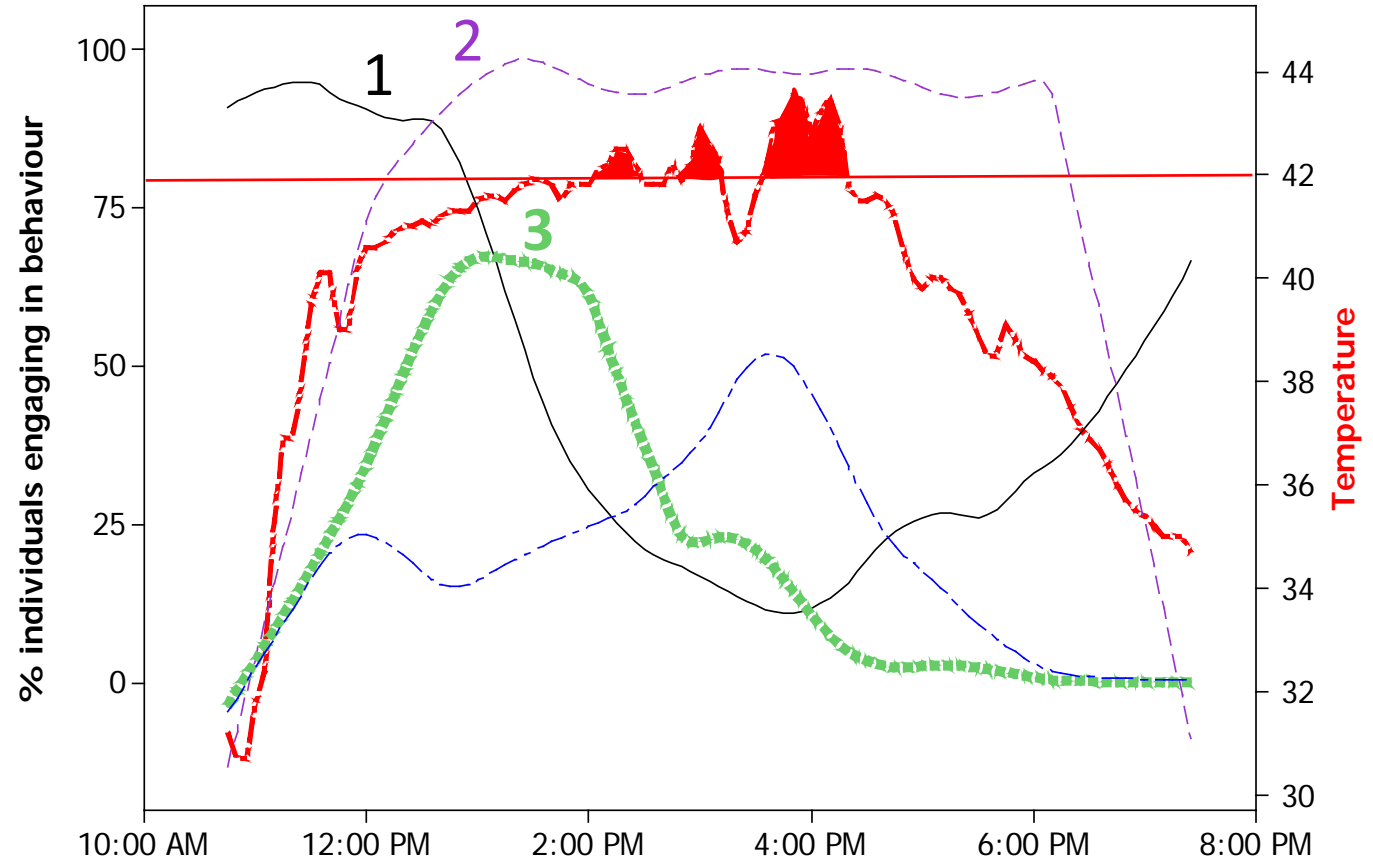
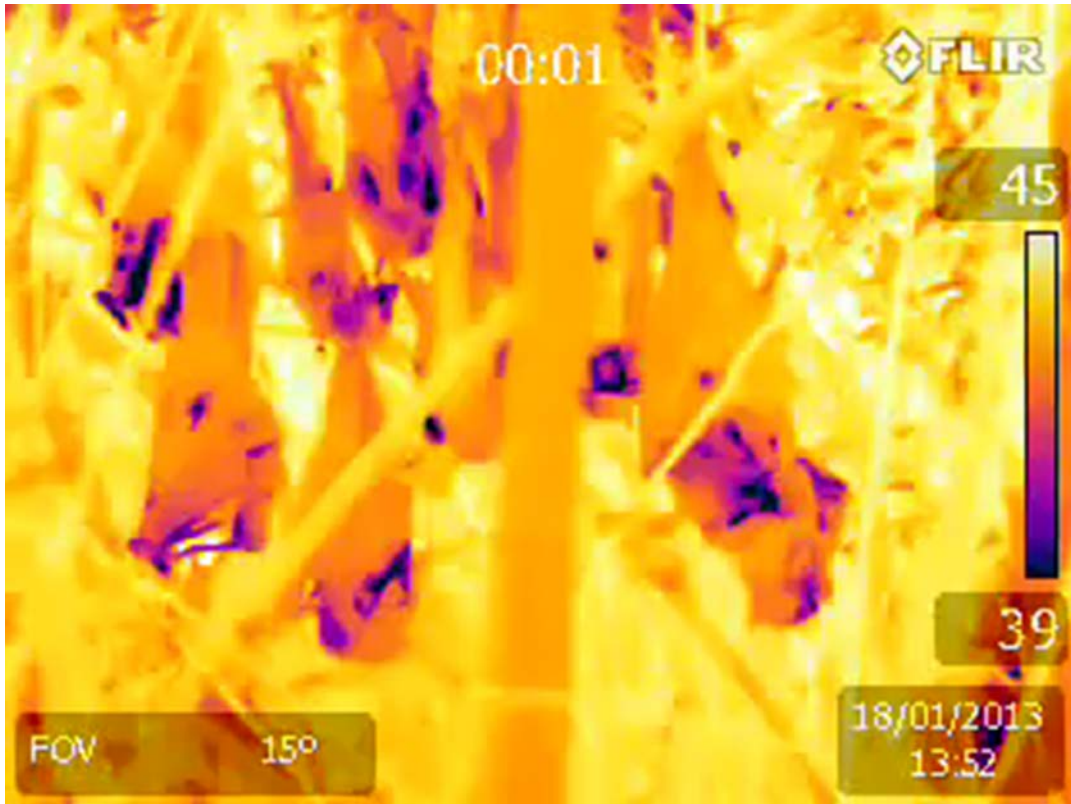
2. Clustering/clumping



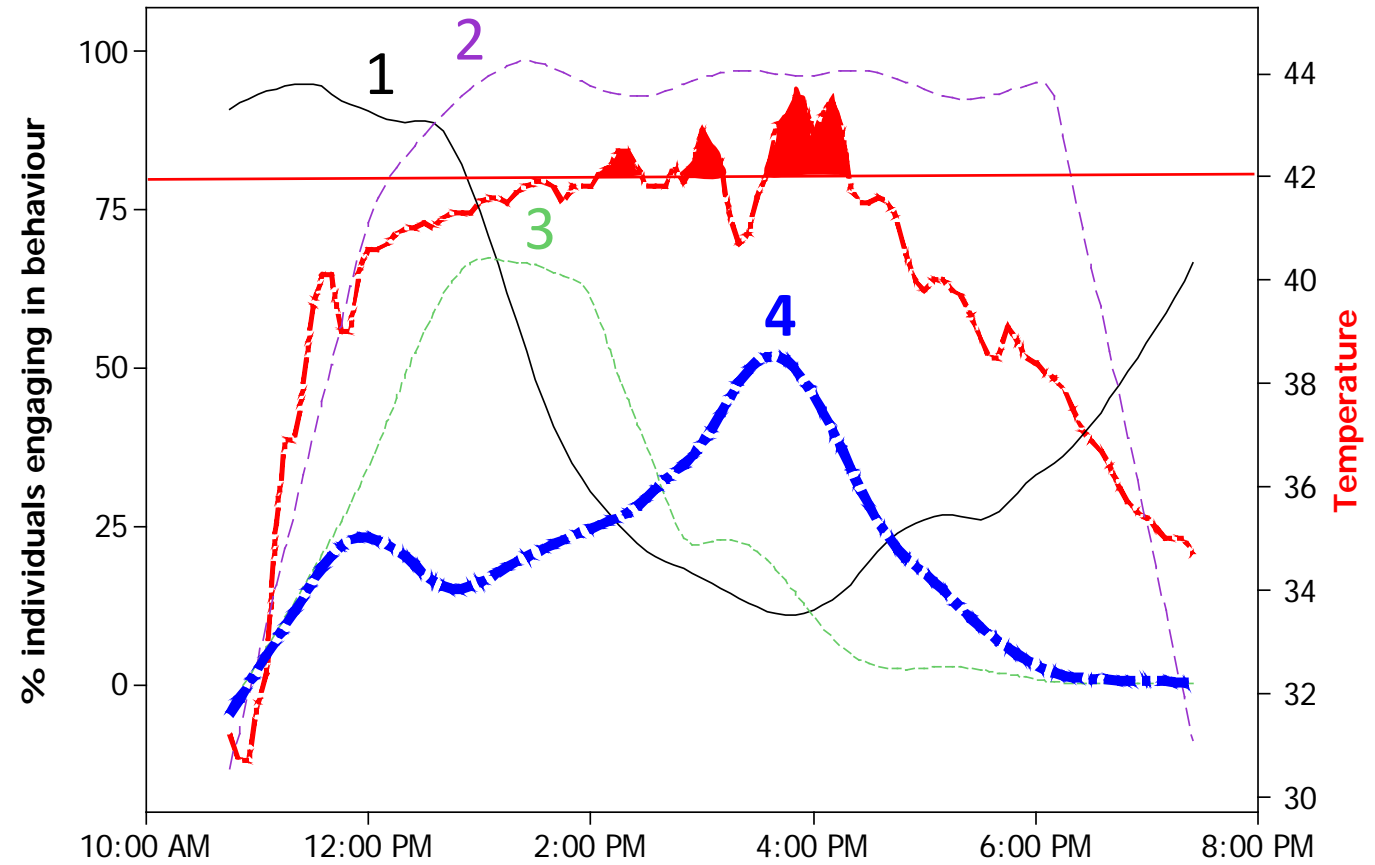
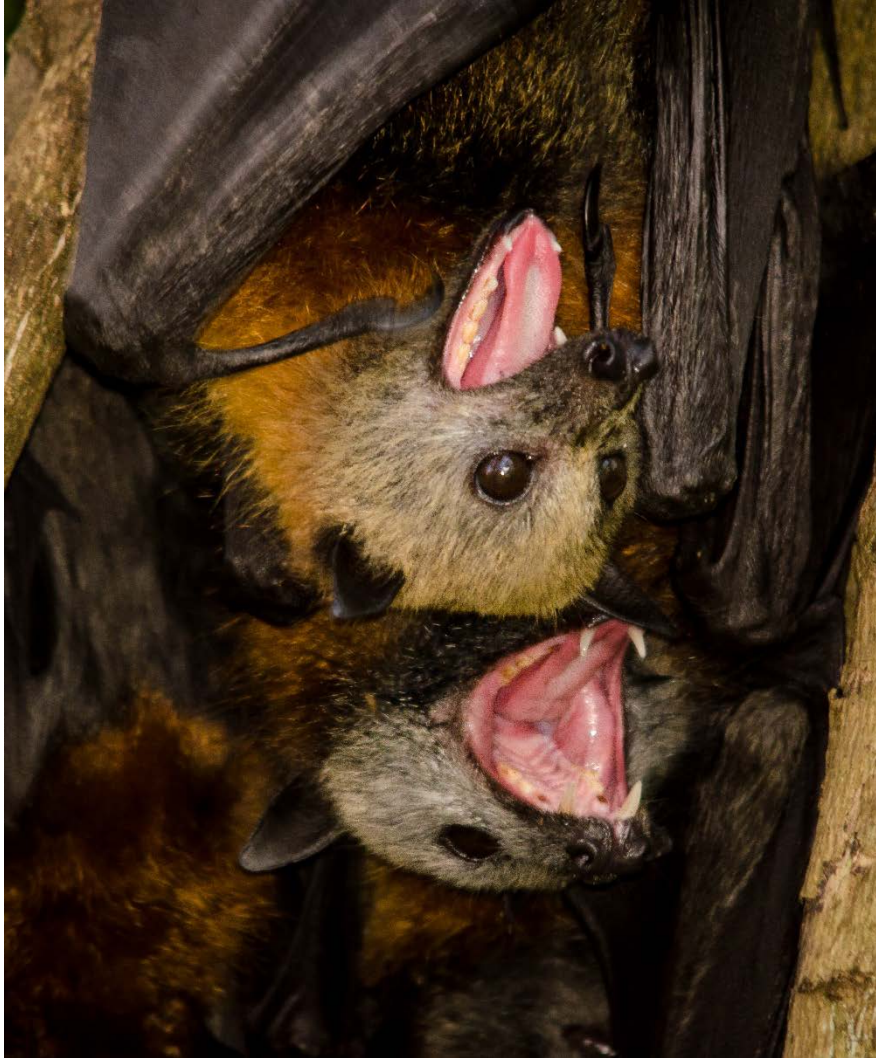
3. Salivation



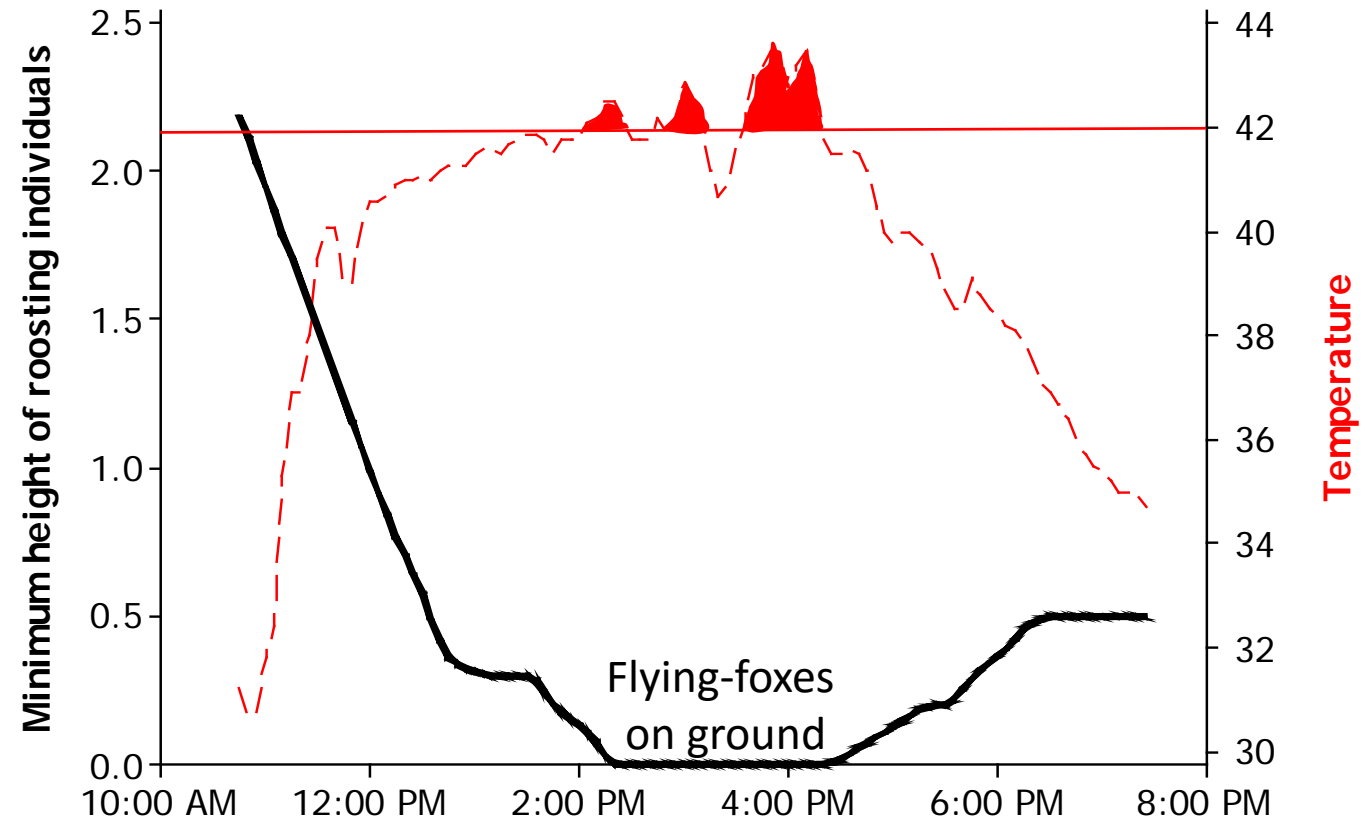
3. Salivation



4. Panting



Beyond 42°C, thermoregulatory mechanisms become overwhelmed



.. and dead bats soon litter the forest floor

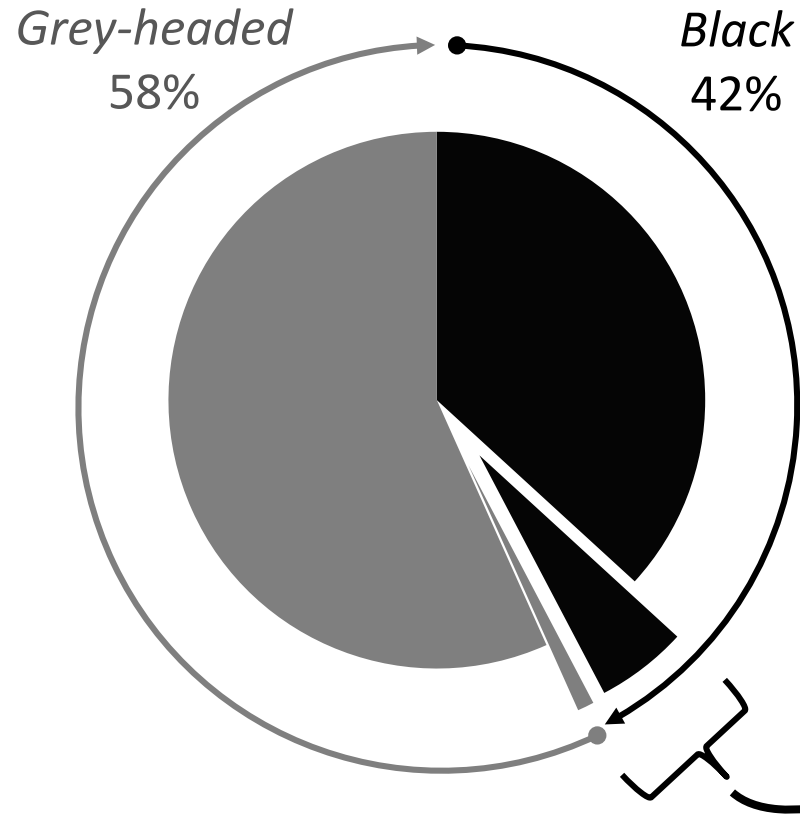


Who died?

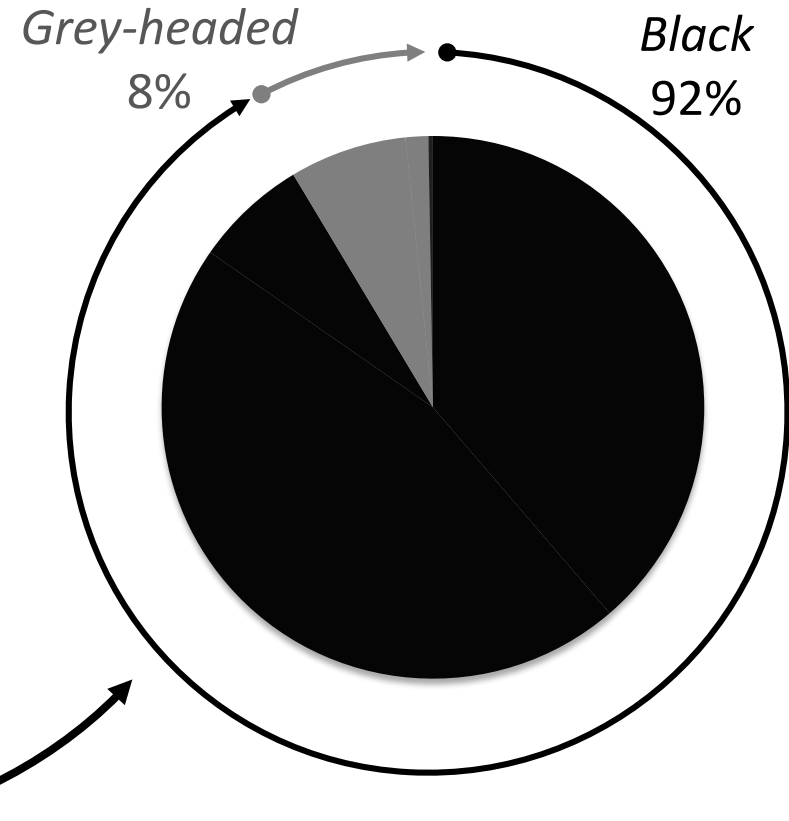


Mortality was higher in the black flying-fox than the grey-headed flying-fox

Present at primary study site: 28,500

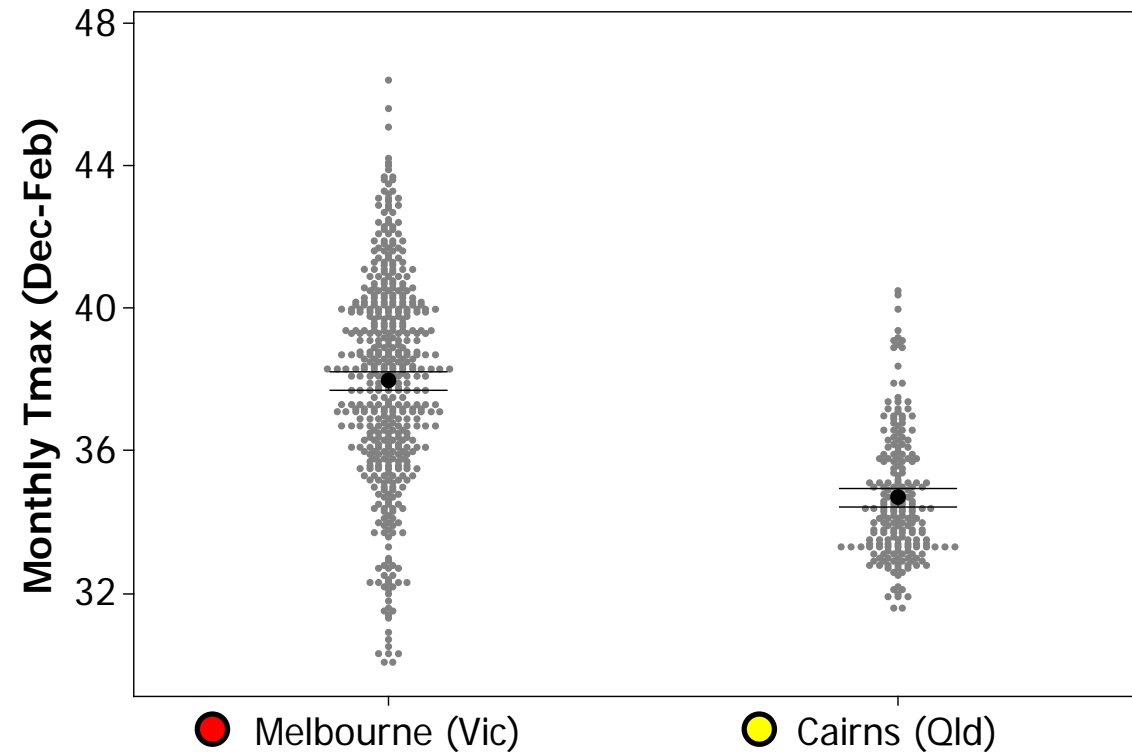
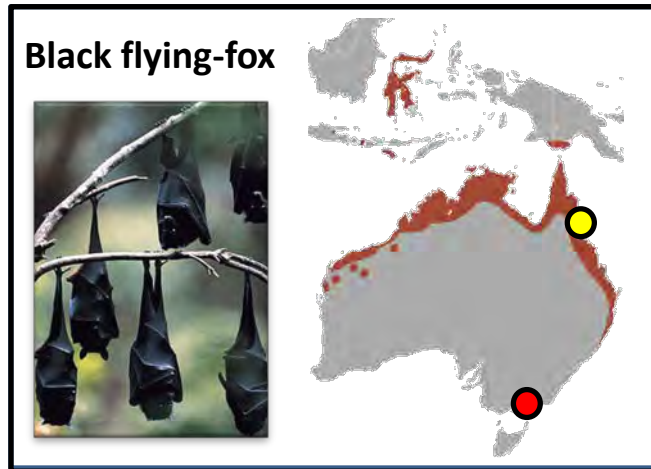


Died: > 1,453



Dallis Park Colony, January 2002

Why is mortality higher in the black flying-fox?



- As a more tropical species, the black flying-fox is exposed to *lower* maximum temperatures

Mortality was higher among juveniles and mature females

	Grey-headed	Black
Juveniles	5%	49%
Mature females	<1%	15%
Mature males	0%	3%



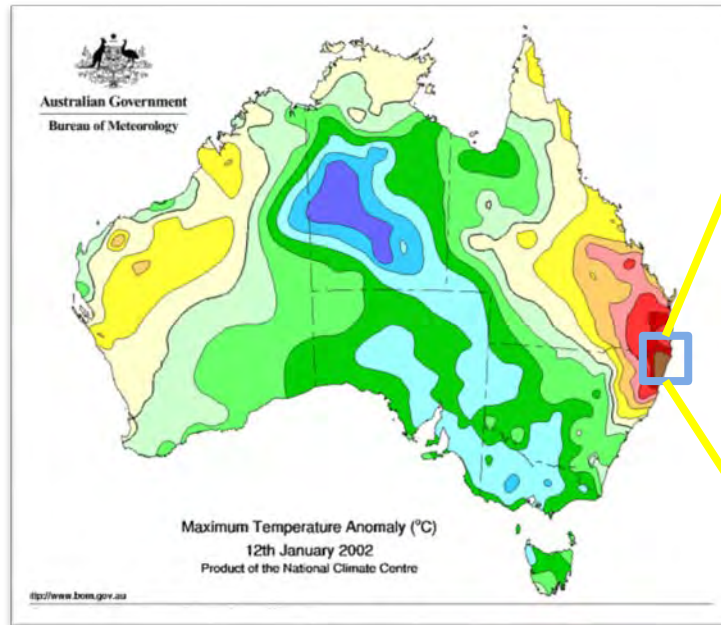
Dallis Park Colony, January 2002

Why is mortality higher among juveniles and mature females?

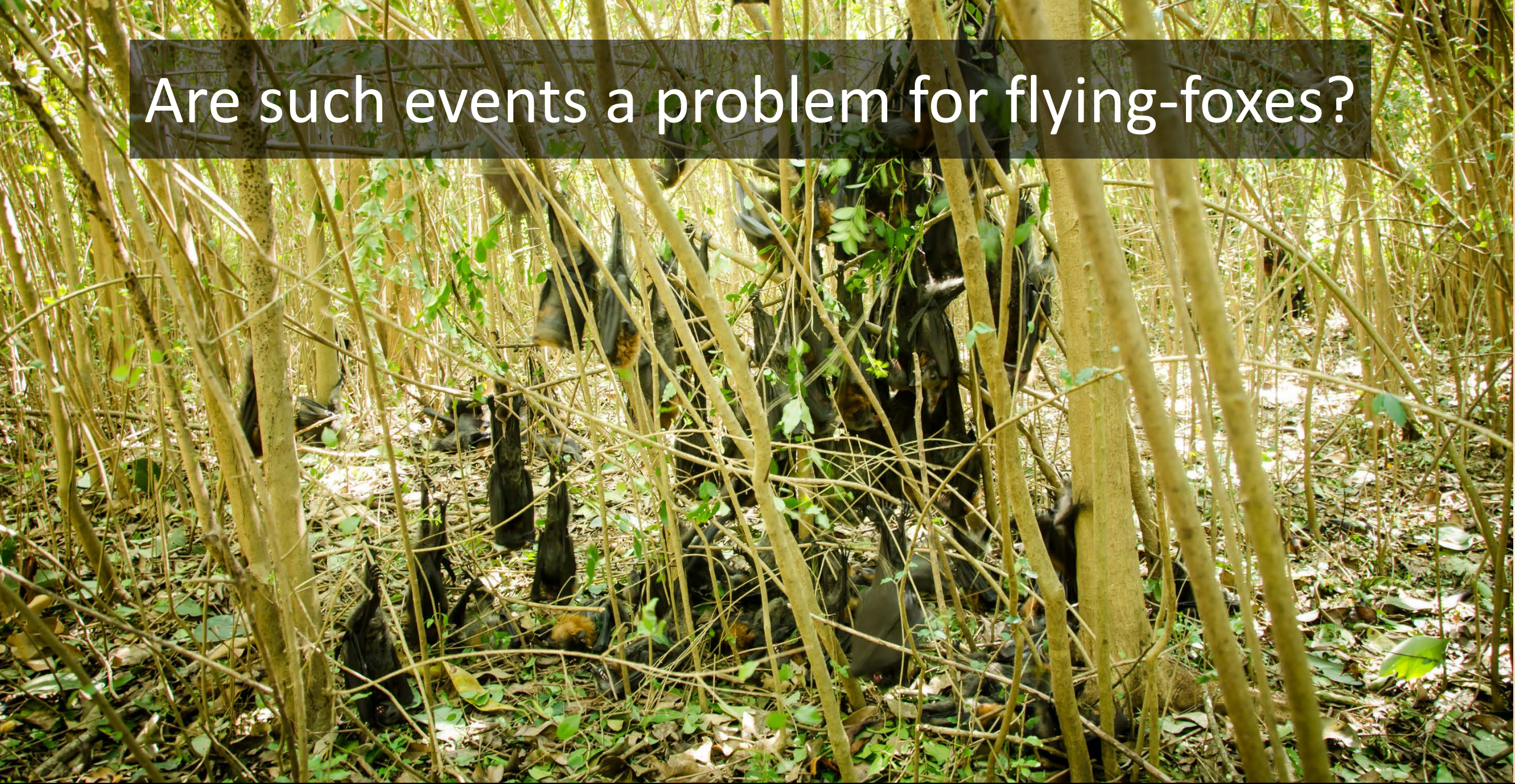
- Juveniles have a lower thermoregulatory capacity (*Bartholomew et al. 1964*)
- Where assessed, mature females that died were lactating, and lactation increases thermoregulatory needs (*Brody 1974*)



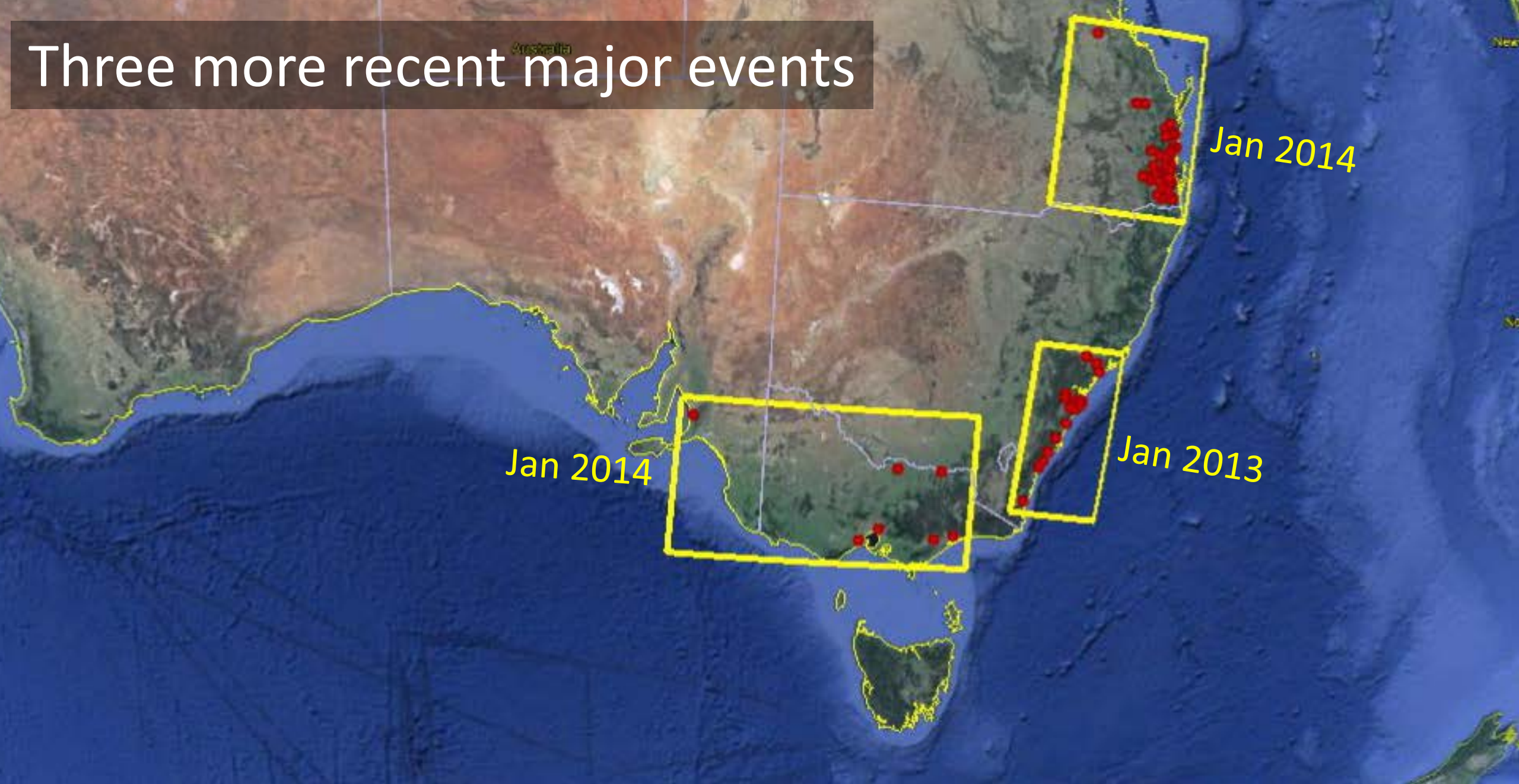
During the January 12th 2002 event, about 4,000 animals died in nine roosts



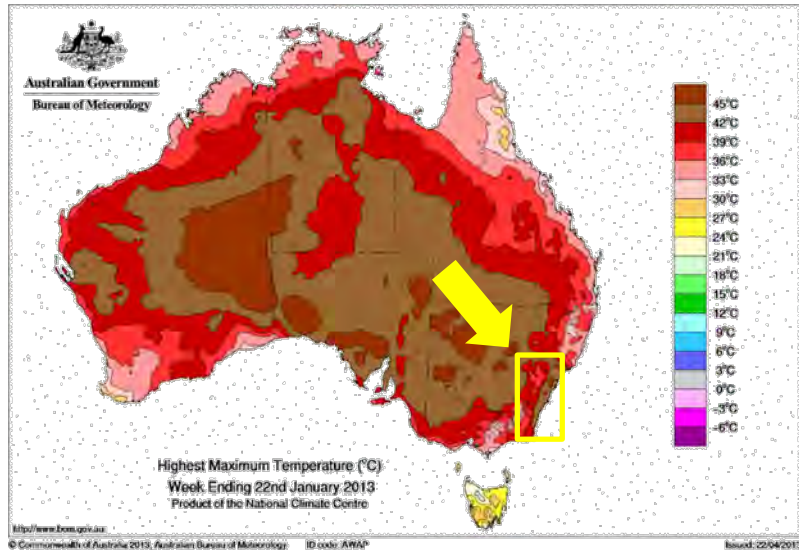
Are such events a problem for flying-foxes?



Three more recent major events

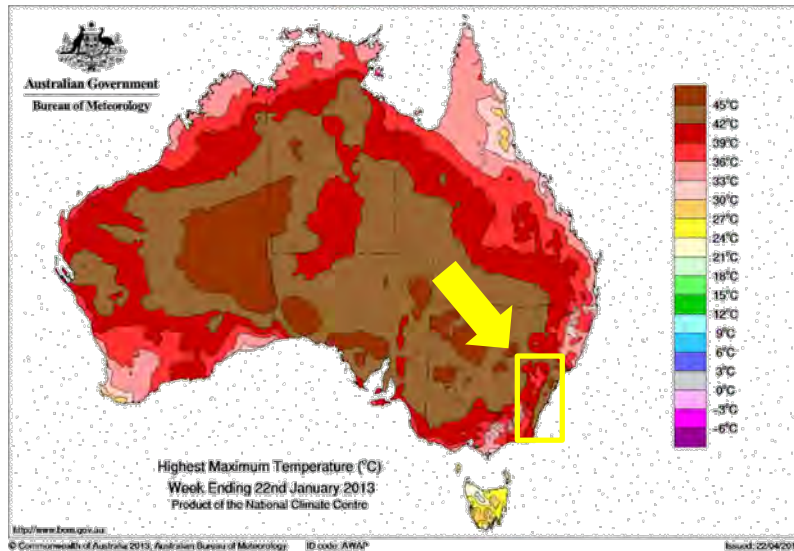


NSW event, January 2013



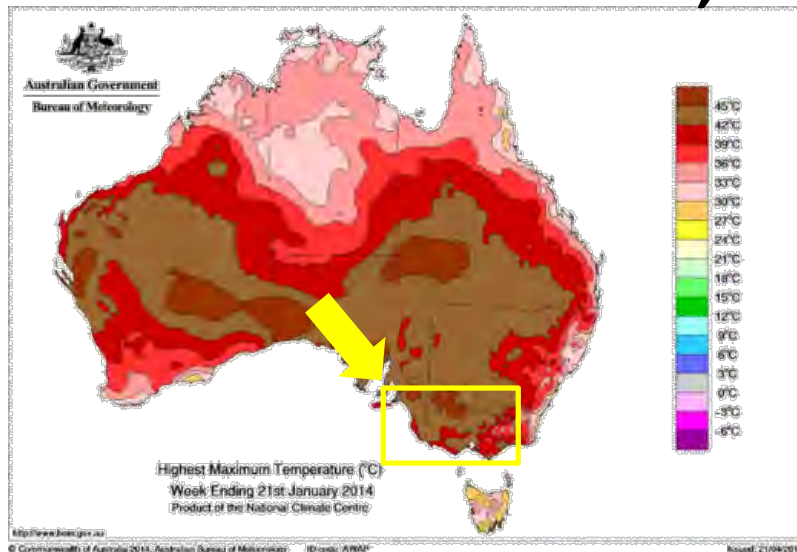
- 18 colonies affected
- 10,000+ dead
- Mortality biased towards
 - Black flying-foxes
 - Juveniles
 - Adult females

NSW event, January 2013



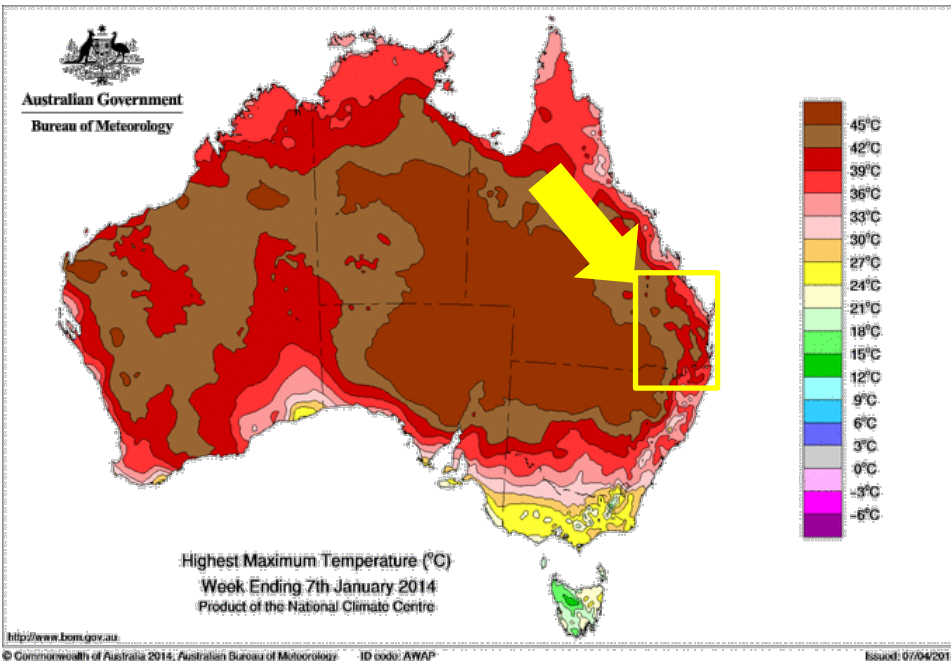
- 18 colonies affected
- 10,000+ dead
- Mortality biased towards
 - Black flying-foxes
 - Juveniles
 - Adult females

Southern states event, January 2014



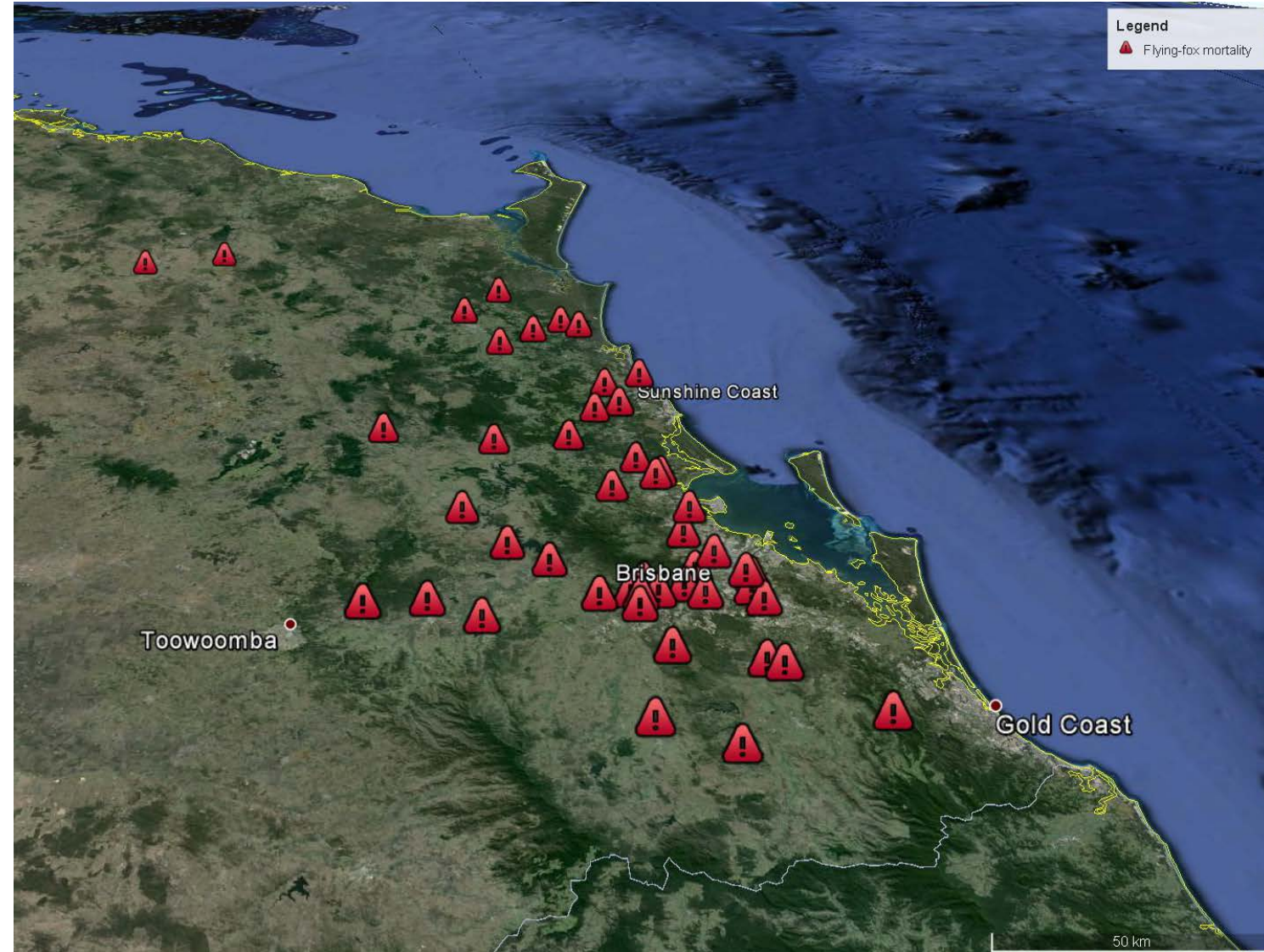
- 7 colonies affected
- 4,500+ dead
- Mortality biased towards
 - Juveniles
 - Adult females

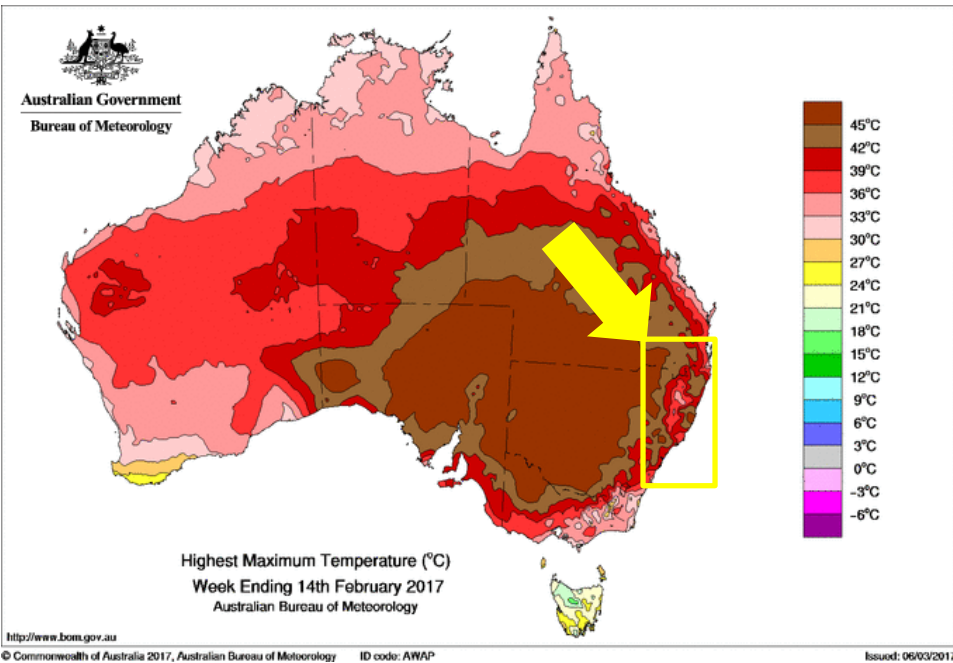
SEQ event, January 2014



- 52+ colonies affected
- 45,500+ dead
- Mortality biased towards
 - Black flying-foxes
 - Juveniles
 - Adult females

➤ **~50% OF ALL BLACK FLYING-FOXES DIED!**





Another major event: 12-14 February 2017

- At least 15 colonies affected
- 10,000+ dead (and counting..)
- Mortality biased towards
 - Black flying-foxes
 - Juveniles
 - Adult females

NEWS ABC
LOCATION: Sydney, NSW
TUESDAY 25°C
Currently 25°
Feels like 25°
MIN 21°

BREAKING NEWS SA will build gas power station, 'Australia's biggest battery' as part of energy security plan

Heatwave kills thousands of bats across New South Wales
ABC North Coast
Posted 13 Feb 2017, 5:48pm

Mercury
News | Local News
Flying Fox rescuer inundated after heatwave
23 Feb 2017, 7:11pm

The barrage of record-breaking heatwaves has left untold numbers of the Hunter's native flying foxes dead or on the verge. A "starvation year" and mid-40 degree days have left more than a thousand bats dead, vulnerable colonies and animal rescuers struggling.

HANGING. Bats socialise in the aviary at Ms Hopper's Mitchell property. There are 75 flying foxes in her care.

"It's been horrific, absolutely horrific." Native Animal Trust Fund carer Judy Hopper said.

The latest heatwave, which saw Maitland, Cessnock and Singleton break temperature records, put extreme stress on bat colonies. In Singleton volunteers are still pulling dead animals from Burdekin Park - the body count is expected to climb to 1000.

VULNERABLE. Flying fox rescuer Judy Hopper holds one of the bats saved from a recent series of heatwaves. Pictures: Perry Duffin

HERALD
Wildlife Aid blames Singleton bat deaths on lack of tree cover in Burdekin Park
Brodie Owen
15 Feb 2017, 10:08 p.m.

The Bellinger Shire Courier-Sun
Heat, starvation: how much more can bats take?
14 Feb 2017, 2:33 p.m.

It could have been worse - but that's not exactly saying it was good. The extreme heat that permeated the Valley on the weekend, and throughout the hot North Coast, led to an estimated 200 bats dying at the island, Bellinger.

This figure compares with hundreds more dead in Kempsey and Port Macquarie camps and, devastatingly, thousands were reported deceased in the south east Queensland region and more than 2000 in Casino.

Local resident, consultant wildlife ecologist and PhD (flying foxes) student, Tim Prosser, told the Bellinger Shire Courier-Sun why the Bellinger camp often craves less stress in NSW.

"The reason why we favor Beller is that the island is a good environment - especially as it is the original habitat of the bats," Mr Prosser said.

This contrasts with other areas where they have been moved on - through development, highways, deforestation, community resentment and the like. Yet the Bellinger colony has been allowed to remain in the bats' preferred location.

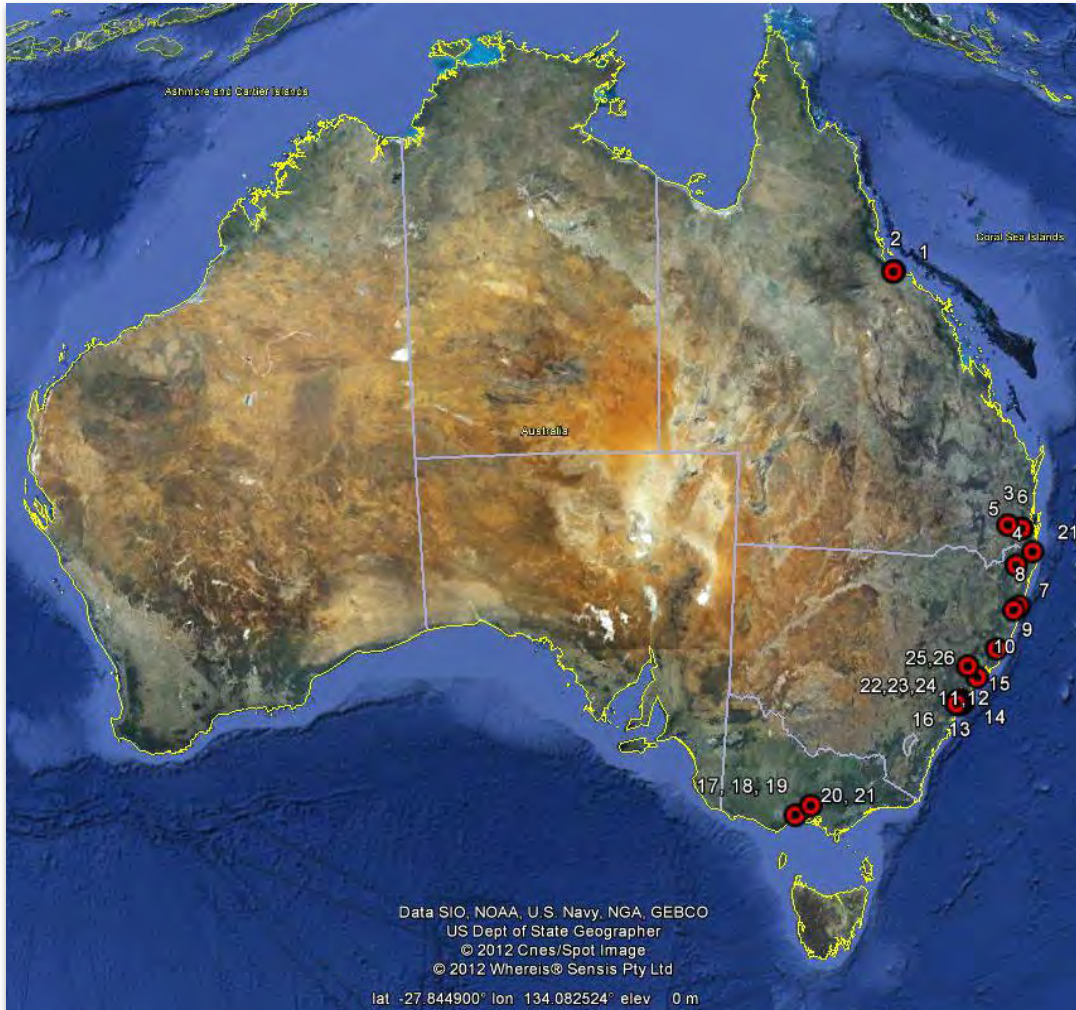
BAKED: Flying foxes lay dead on the ground in Singleton's Burdekin Park after last week's heatwave. Wildlife removal of trees in the park contributed to the heat stress. Picture: Wildlife Aid Inc

ANIMAL welfare organisation Wildlife Aid has blamed the deaths of up to 1000 flying foxes in Singleton in last week's heatwave on the felling of trees in the town's main park.

Northern Star
Community warned to avoid touching flying foxes
FREE

Welbergen et al, unpublished

Are die-offs more common now than in the past?

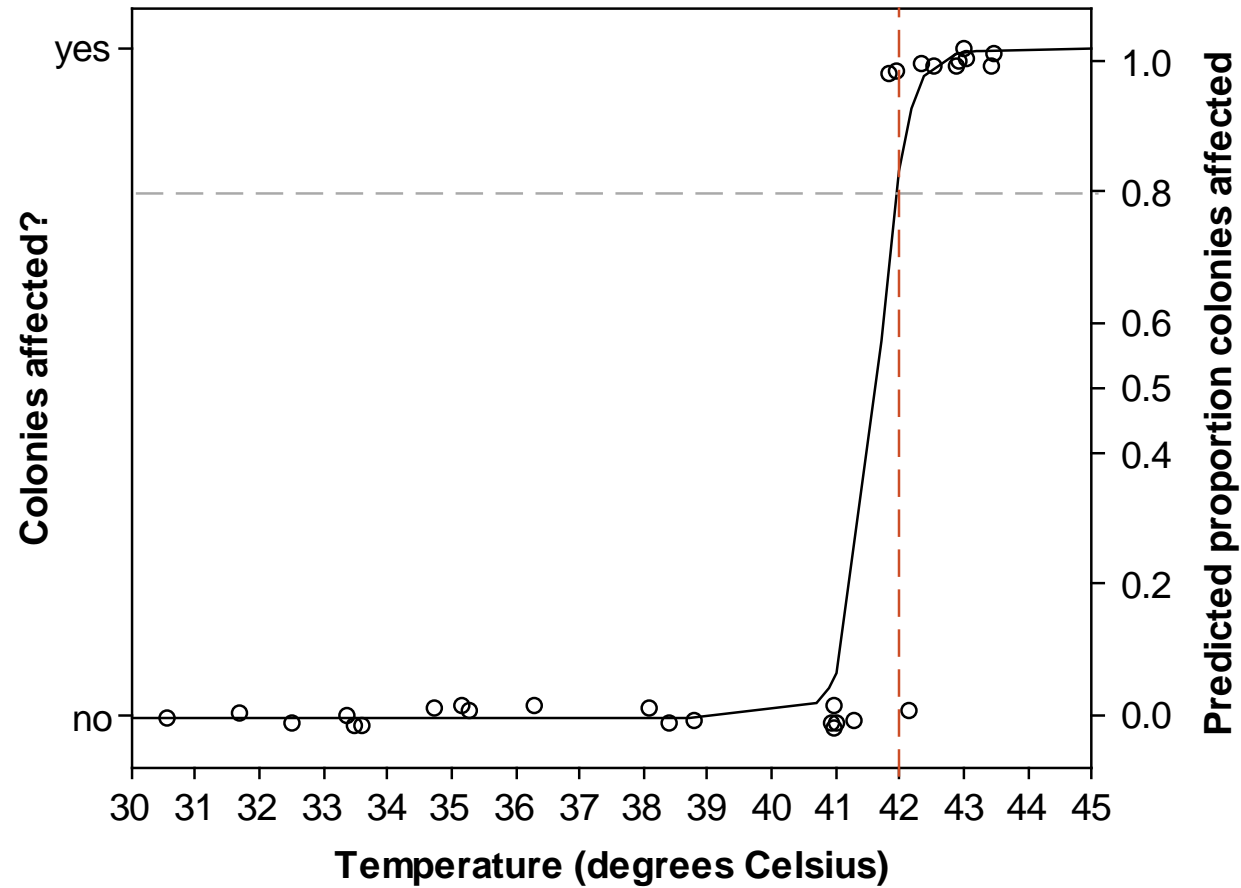


- So far we have found evidence of at least 31 die-off events in Australia
- The earliest recorded die-off dates back to 1791
- 27 die-offs occurred after 1994

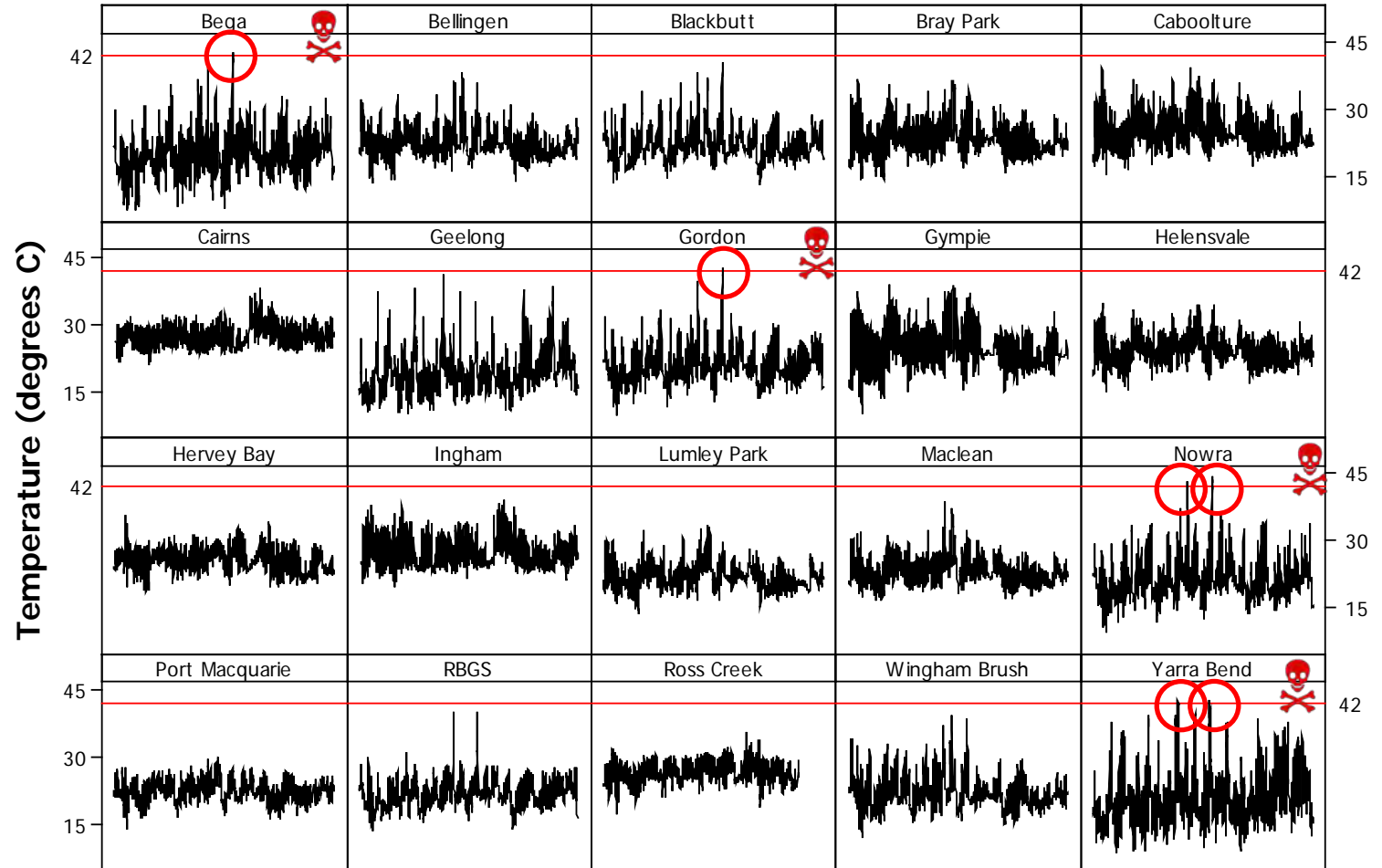


Mortality is strongly associated with $T > 42.0^{\circ}\text{C}$ (107.6°F)

2002 Northern NSW extreme heat event:

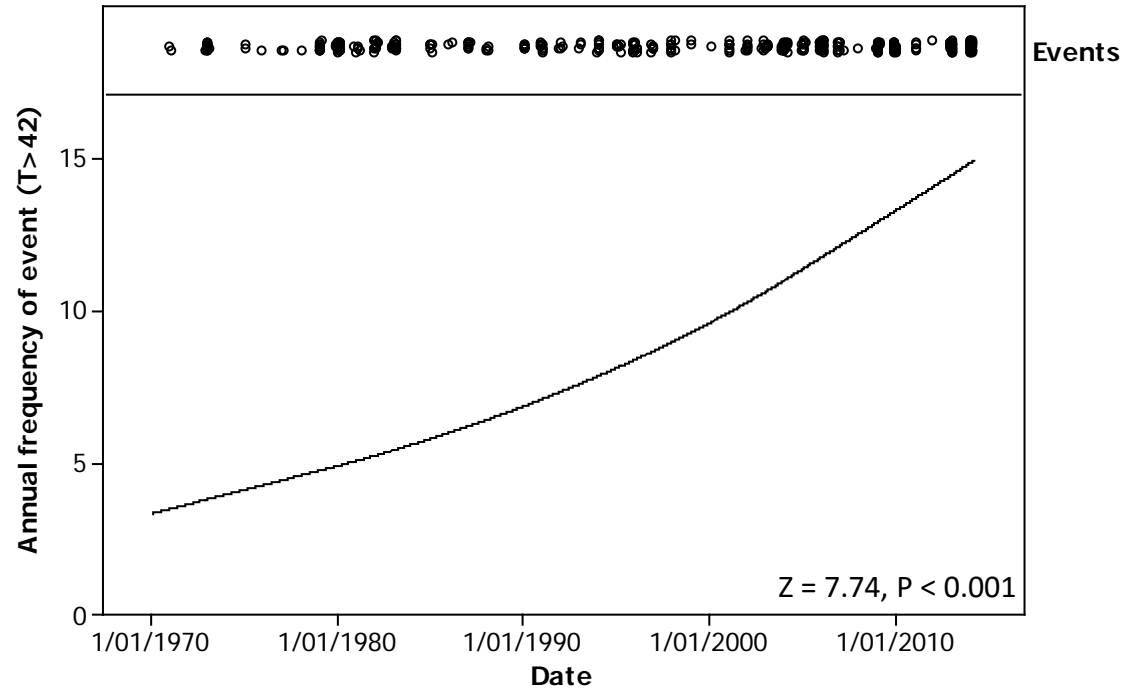


Mortality is strongly associated with $T > 42.0^{\circ}\text{C}$ (107.6°F)

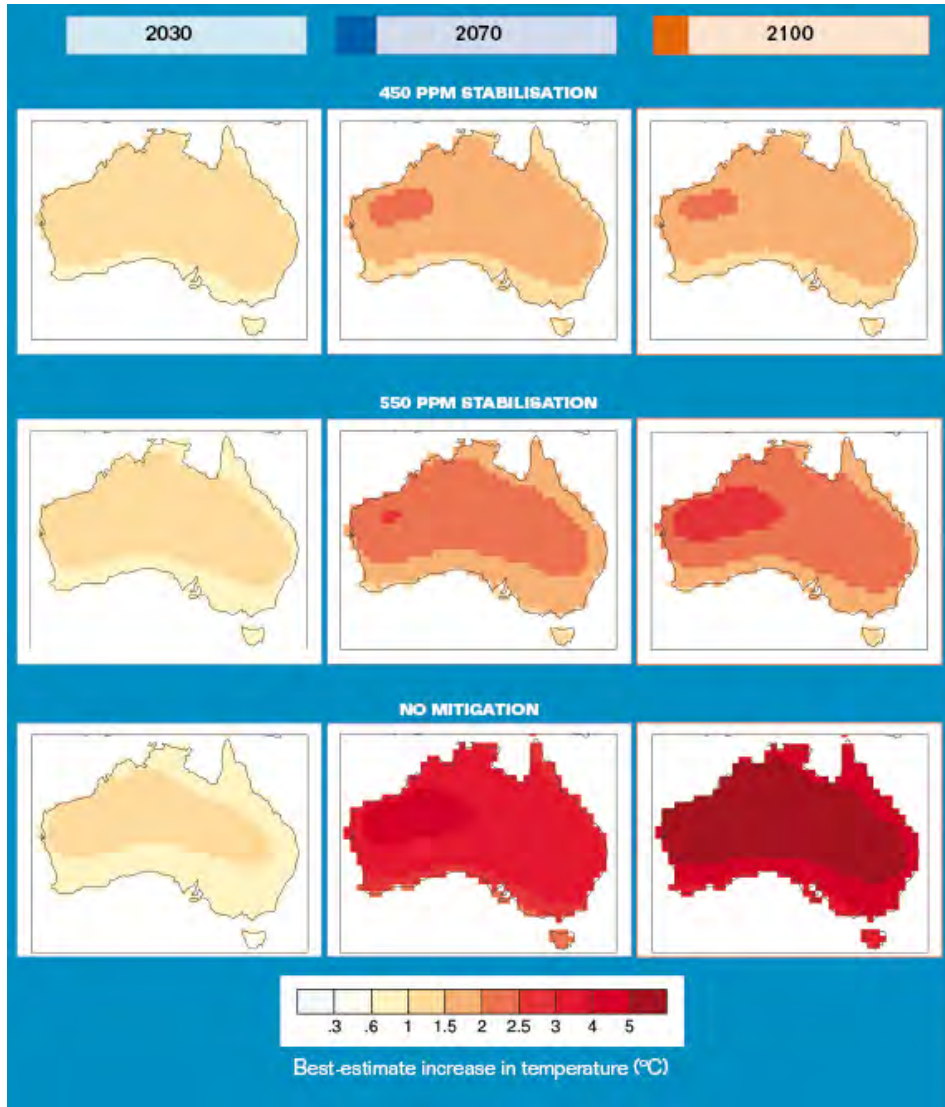


Roost are now more often exposed to $T > 42.0^{\circ}\text{C}$

- The probability that flying-foxes will encounter $> 42^{\circ}\text{C}$ temperatures has increased almost *three-fold* since the 1970s



Will die-offs become more common in the future?



- There is little doubt that as Australian summers become hotter, die-offs will become more frequent and widespread
- Our current work aims to build a mechanistic understanding of the vulnerability of flying-foxes to such events



Canaries in the Anthropocene?

- Flying-fox die-offs are particularly conspicuous events
- This raises concern that similar impacts occur in species with more solitary and cryptic lifestyles
- Indeed, heat-related die-offs have been reported in other fauna, including koalas, Carnaby's black cockatoos, budgerigars, bumblebees, butterflies, and humans..



Flying-fox die-offs are an important wildlife management issue

- Extreme heat events are a major cause of death for flying-foxes (Tidemann & Nelson 2011)
- They can place enormous demands on land managers and wildlife carers
- There is an urgent need to streamline management responses!

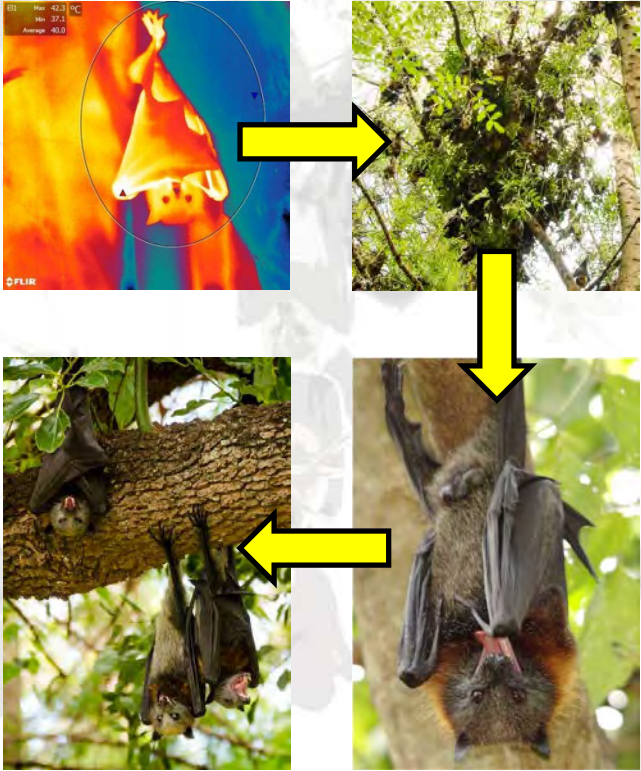


Responding to flying-fox heat stress events

Before



During



After



Responding to flying-fox heat stress events

Before



During



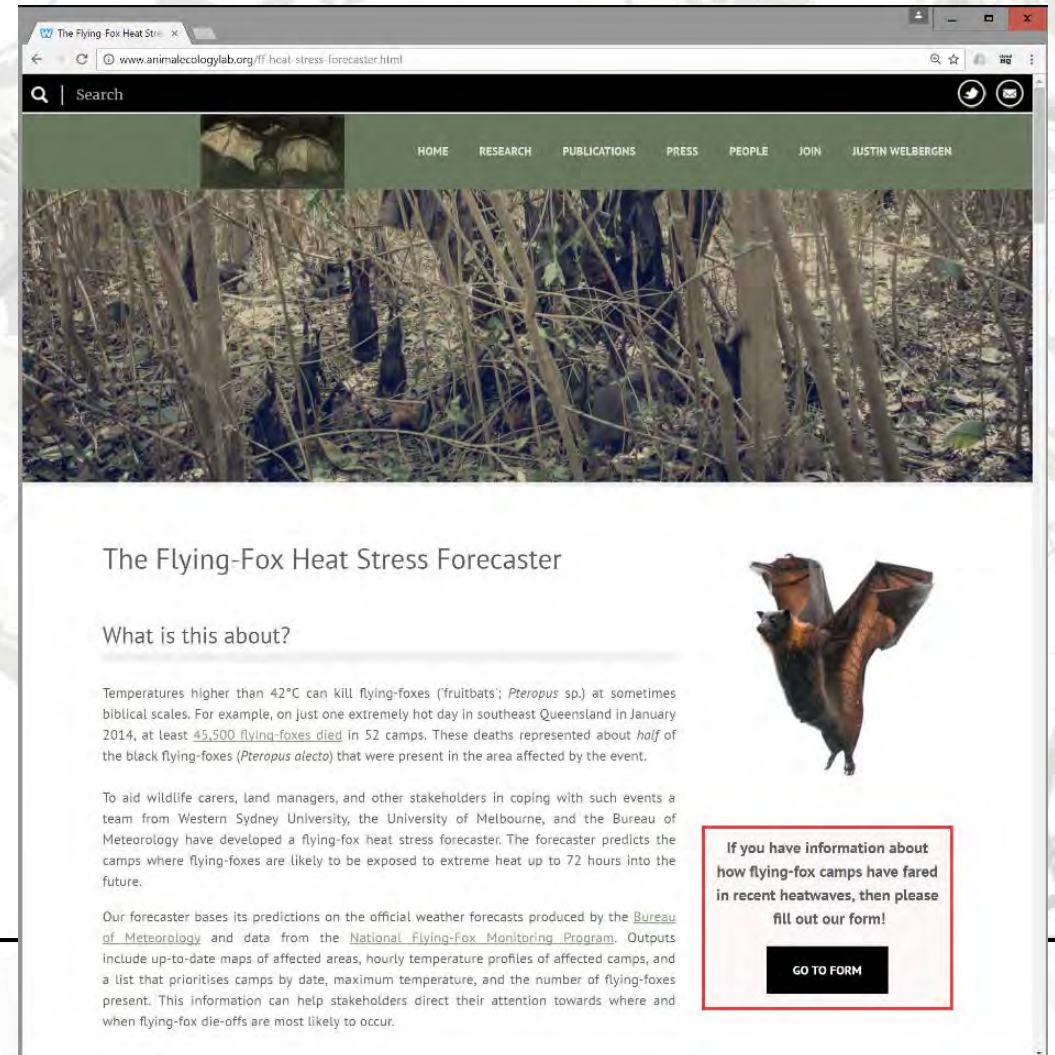
After



Before - The flying-fox heat stress forecaster

- Built in collaboration with the University of Melbourne, CSIRO, and the Australian Bureau of Meteorology
- Predicts up to 72 hours into the future where known flying-fox roosts are likely to be exposed to extreme heat ($T > 42^{\circ}\text{C}$)
- Mortality forecasts have high accuracy (24 hrs = 77%; 48 hrs = 73%, as tested against past mortality data)

www.animalecologylab.org/ff-heat-stress-forecaster



The Flying-Fox Heat Stress Forecaster

What is this about?

Temperatures higher than 42°C can kill flying-foxes (fruitbats; *Pteropus* sp.) at sometimes biblical scales. For example, on just one extremely hot day in southeast Queensland in January 2014, at least 45,500 flying-foxes died in 52 camps. These deaths represented about half of the black flying-foxes (*Pteropus alecto*) that were present in the area affected by the event.

To aid wildlife carers, land managers, and other stakeholders in coping with such events a team from Western Sydney University, the University of Melbourne, and the Bureau of Meteorology have developed a flying-fox heat stress forecaster. The forecaster predicts the camps where flying-foxes are likely to be exposed to extreme heat up to 72 hours into the future.

Our forecaster bases its predictions on the official weather forecasts produced by the [Bureau of Meteorology](#) and data from the [National Flying-Fox Monitoring Program](#). Outputs include up-to-date maps of affected areas, hourly temperature profiles of affected camps, and a list that prioritises camps by date, maximum temperature, and the number of flying-foxes present. This information can help stakeholders direct their attention towards where and when flying-fox die-offs are most likely to occur.

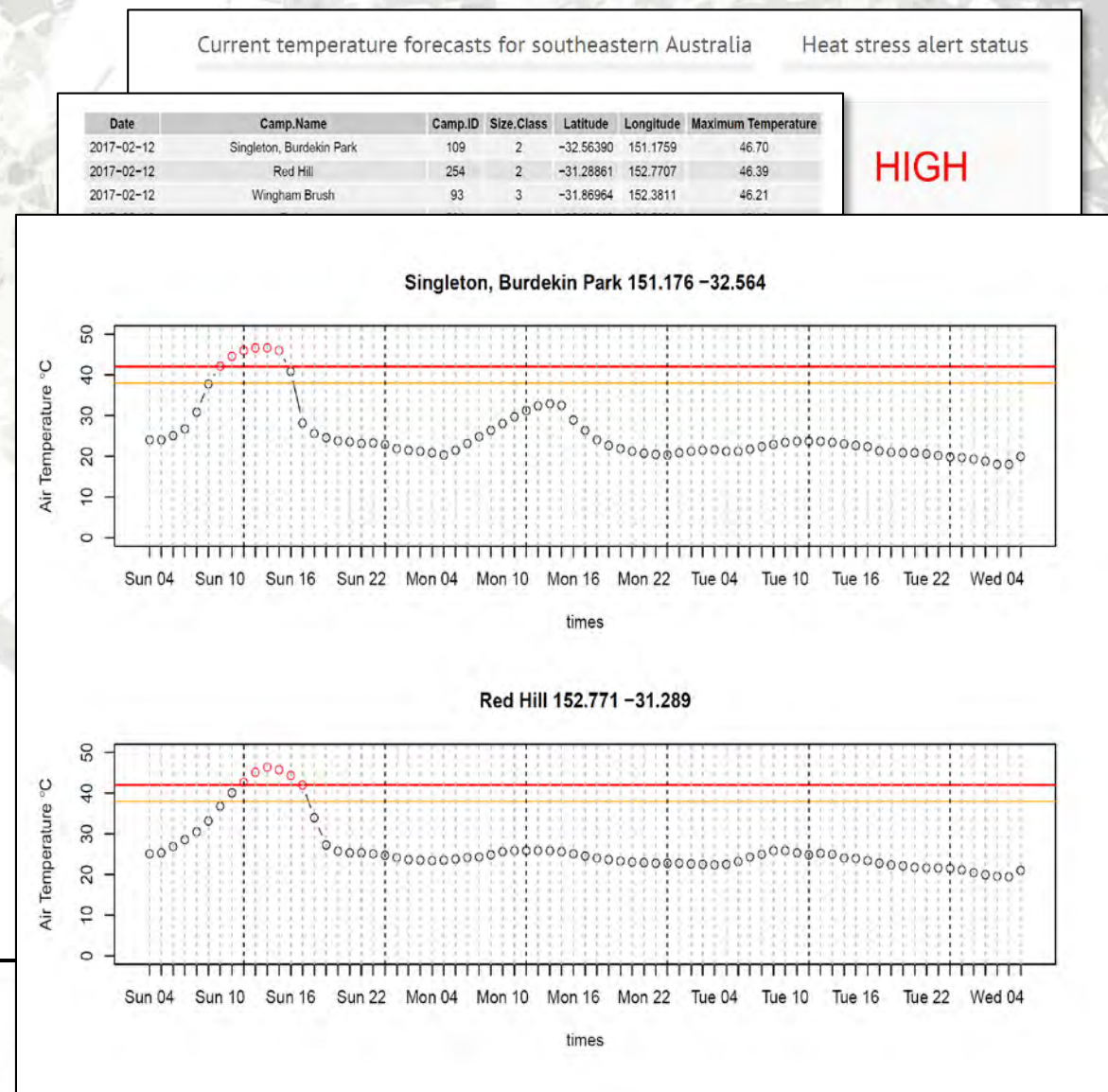
If you have information about how flying-fox camps have fared in recent heatwaves, then please fill out our form!

[GO TO FORM](#)

Before - The flying-fox heat stress forecaster

Outputs

- **Maps** of affected areas
 - **Lists** of priority colonies (ranked by date, temperature, size)
 - **Temperature profiles** of priority colonies
- Outputs help direct wildlife carers, land managers, and health officials towards where and when flying-fox die-offs are likely to occur

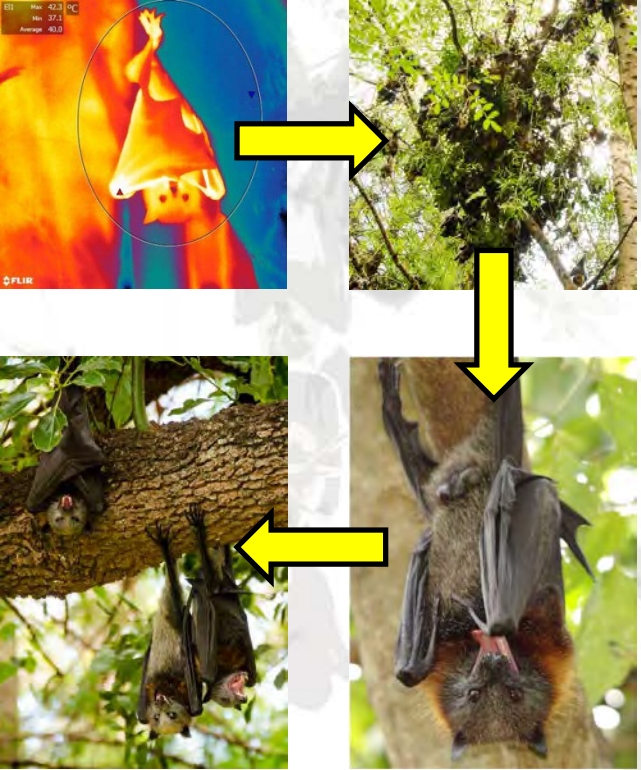


Responding to flying-fox heat stress events

Before



During



After



During - spraying

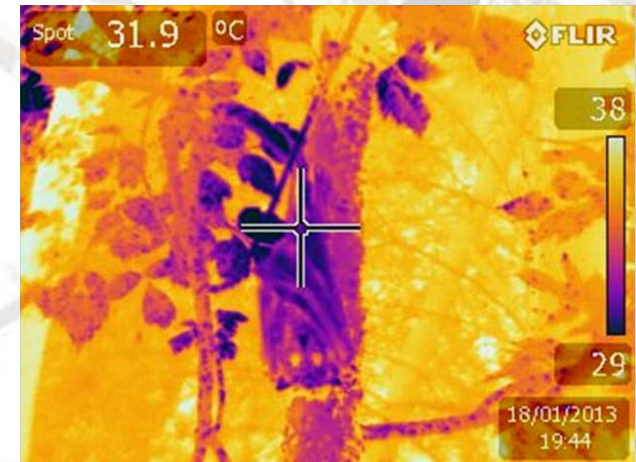
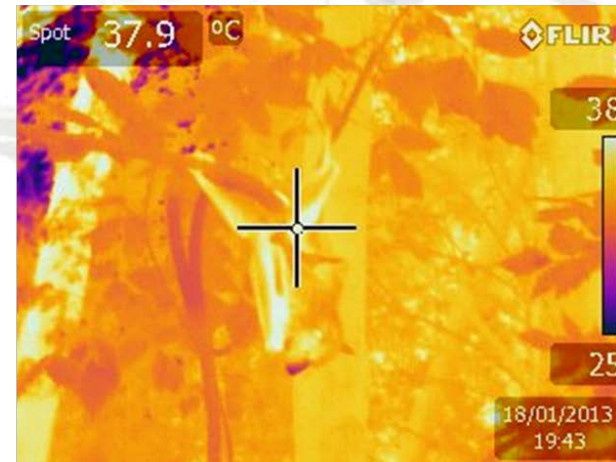
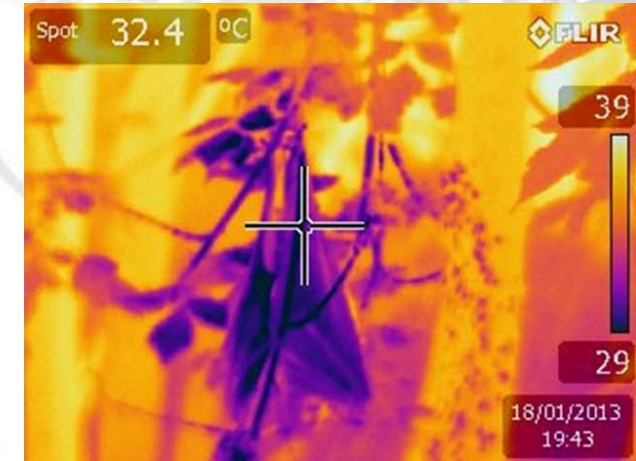
- Spraying of individuals by hand can cool highly distressed animals
- But can disturb other bats!



Before spraying



After spraying



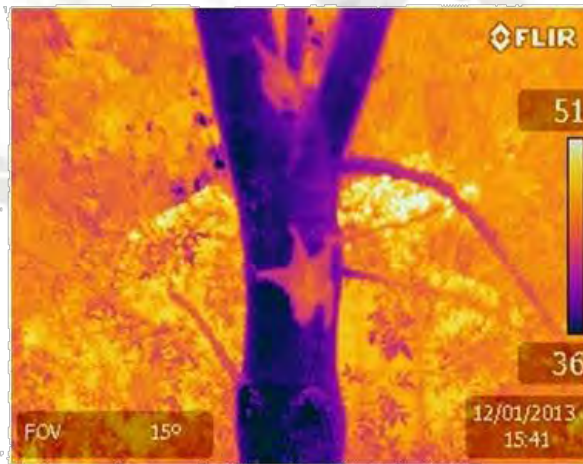
During - wholesale misting of camps

- Decreases temperature but raises humidity, which risks a *net increase* in heat stress for the bats
- Effectiveness not proven at present
- Can disturb bats!



During – disturbing heat-stressed individuals

- Entering a camp may lead to increased mortality when animals are forced to leave their cooler microhabitats



During - removing animals from a camp

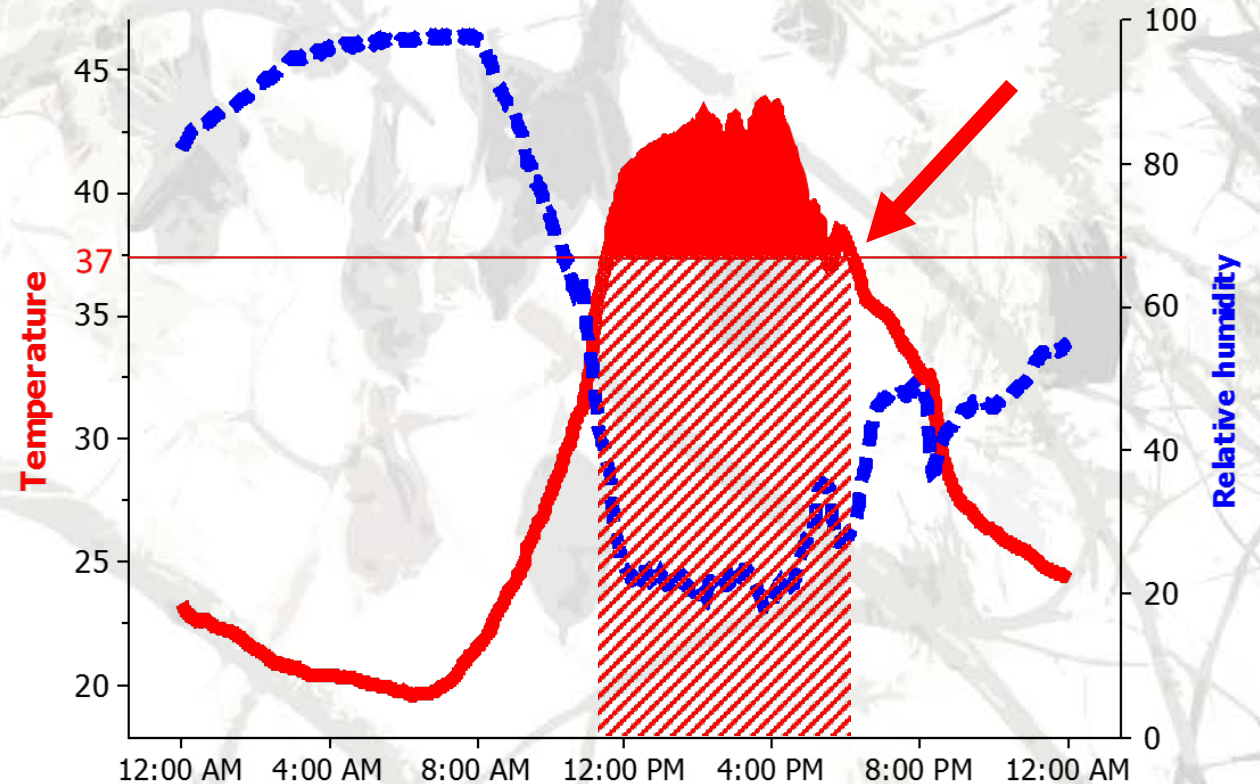
- Many animals will recover without intervention..

All heat stressed individuals in this cluster of young survived 47° C



During - removing animals from a camp

- Therefore, intervention is generally not recommended, unless animals are still unresponsive after temperatures have dropped below $\sim 37^{\circ}\text{C}$.



Responding to flying-fox heat stress events

Before



During

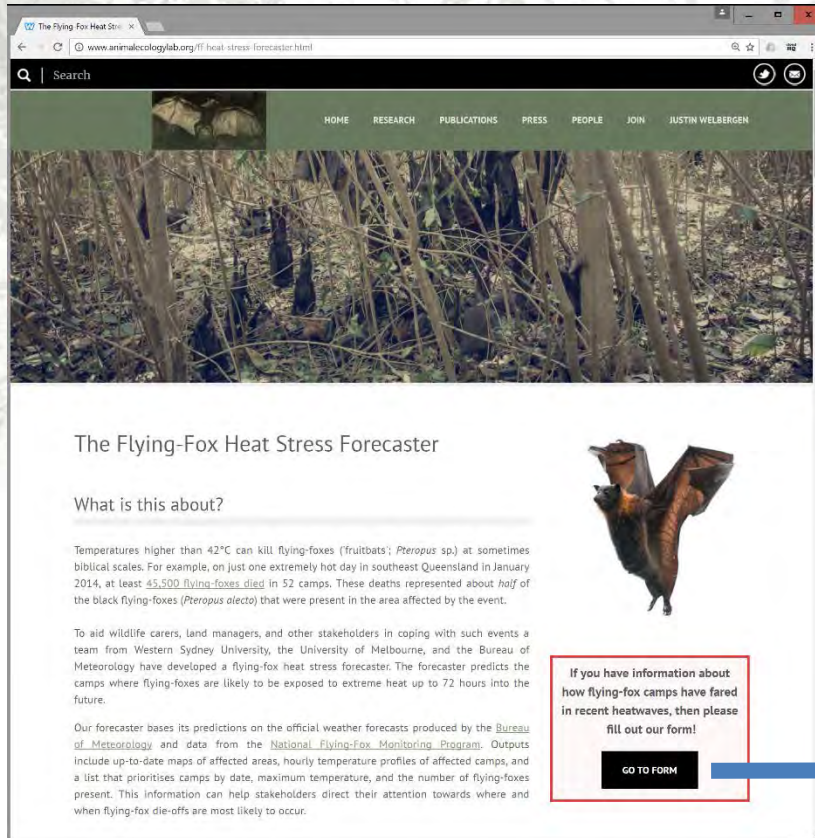


After



After – data collection

www.animalecologylab.org/ff-heat-stress-forecaster



The Flying-Fox Heat Stress Forecaster

What is this about?

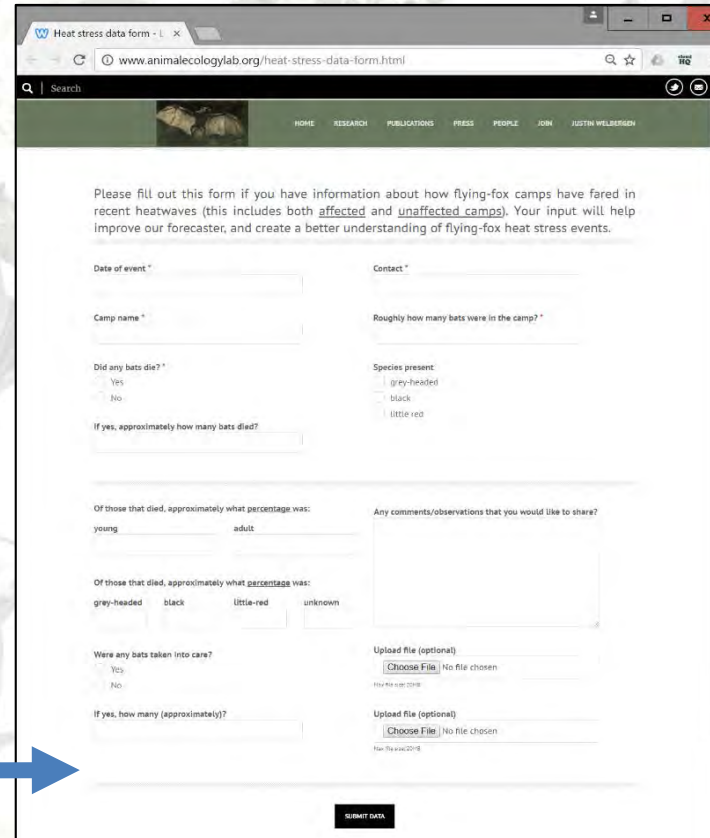
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If you have information about how flying-fox camps have fared in recent heatwaves, then please fill out our form!

GO TO FORM



Heat stress data form - 1

Please fill out this form if you have information about how flying-fox camps have fared in recent heatwaves (this includes both affected and unaffected camps). Your input will help improve our forecaster, and create a better understanding of flying-fox heat stress events.

Date of event *

Contact *

Camp name *

Roughly how many bats were in the camp? *

Did any bats die? *

Yes

No

Species present

grey-headed

black

little red

If yes, approximately how many bats died?

Of those that died, approximately what percentage was:

young adult

Of those that died, approximately what percentage was:

grey-headed black little-red unknown

Were any bats taken into care?

Yes

No

Upload file (optional)

No file chosen

File No. 000 2018

If yes, how many (approximately)?

Upload file (optional)

No file chosen

File No. 000 2018

Submit data

Citizen Science Data:

- Contributes to more effective management
- Improves the heat stress forecaster
- Helps create a better understanding of the long-term impacts on flying-foxes

After – disposal of bodies

- Dead bodies should quickly be collected by ABLV vaccinated people and with appropriate PPE
- Carcasses can be dropped at registered landfill sites



<http://www.environment.nsw.gov.au/animals/flying-fox-heat.htm>

<http://www.health.nsw.gov.au/infectious/factsheets/pages/rabies-australian-bat-lyssavirus-infection.aspx>

THANK YOU!

Nick Davies, Stefan Klose, Nicki Markus, Peggy Eby, Paul Racey, Anne Goldizen, Tim Clutton-Brock, Hugh Spencer, Lesley Hall, David Westcott, Adam McKeown, Elisabeth Kalko, Jeremy VanDerWal, Stephen Williams, Chris Turbill

John Martin, Carol Booth, Sophie Golding, Louise Saunders, Dave Pinson, Storm Stanford, Tim Pearson, Megan Churches, Sonia Stanvic, Linda Collins, Viki McDonald, Kerry Parry-Jones, Jan Virgo, Gerardine Hawkins, Steve Amesbury, Jennefer Maclean, Isobel Johnston, Jaala Presland, Kaye & Marcus Holdsworth, Terry Reardon, Kyle Armstrong, and many others

Behavioural Ecology Group (University of Cambridge); Plant-animal Interactions Group (HIE/Western Sydney University); Centre for Tropical Biodiversity and Climate Change (James Cook University)

Australian Research Council (ARC); National Environmental Research Program (NERP); King's College; Darwin College; Isaac Newton Trust; the Cambridge European Trust; Stichting Vrijvrouwe van Renswoude; Natural Environment Research Council (NERC, UK)

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