One Health and Antimicrobial Stewardship – Why wildlife matter

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I acknowledge the Traditional Custodians of the land where Macquarie University is located, the Wallumattagal Clan of the Dharug nation, and the First Peoples of the lands where our studies were undertaken.

I appreciate that we can meet today on lands of the Wurundjeri, Woi-wurrung and Bunurong Boon Wurrung peoples of the East Kulan.

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- Sabine Schiller – Mres

Marine species

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- Ida Lundback – Mres

Tasmanian devils

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- Carolyn Hogg - U Syd

Koala

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Platypus

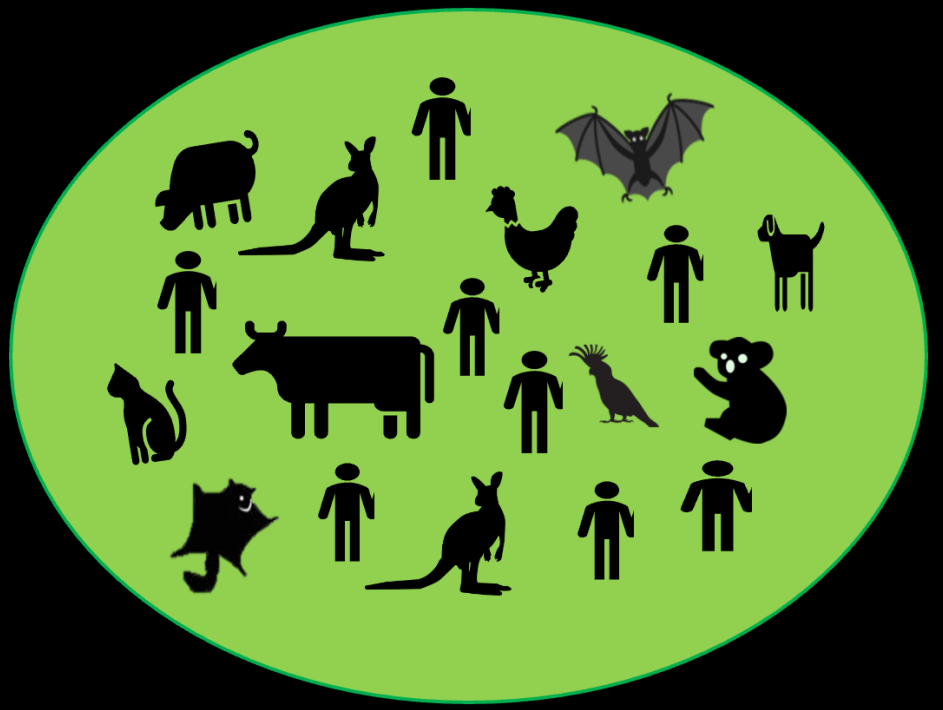
- Nadine Samy (Mres)
- Gilad Bino

Antimicrobial resistance and wildlife

AMR HAS NO SPECIES BOUNDARIES

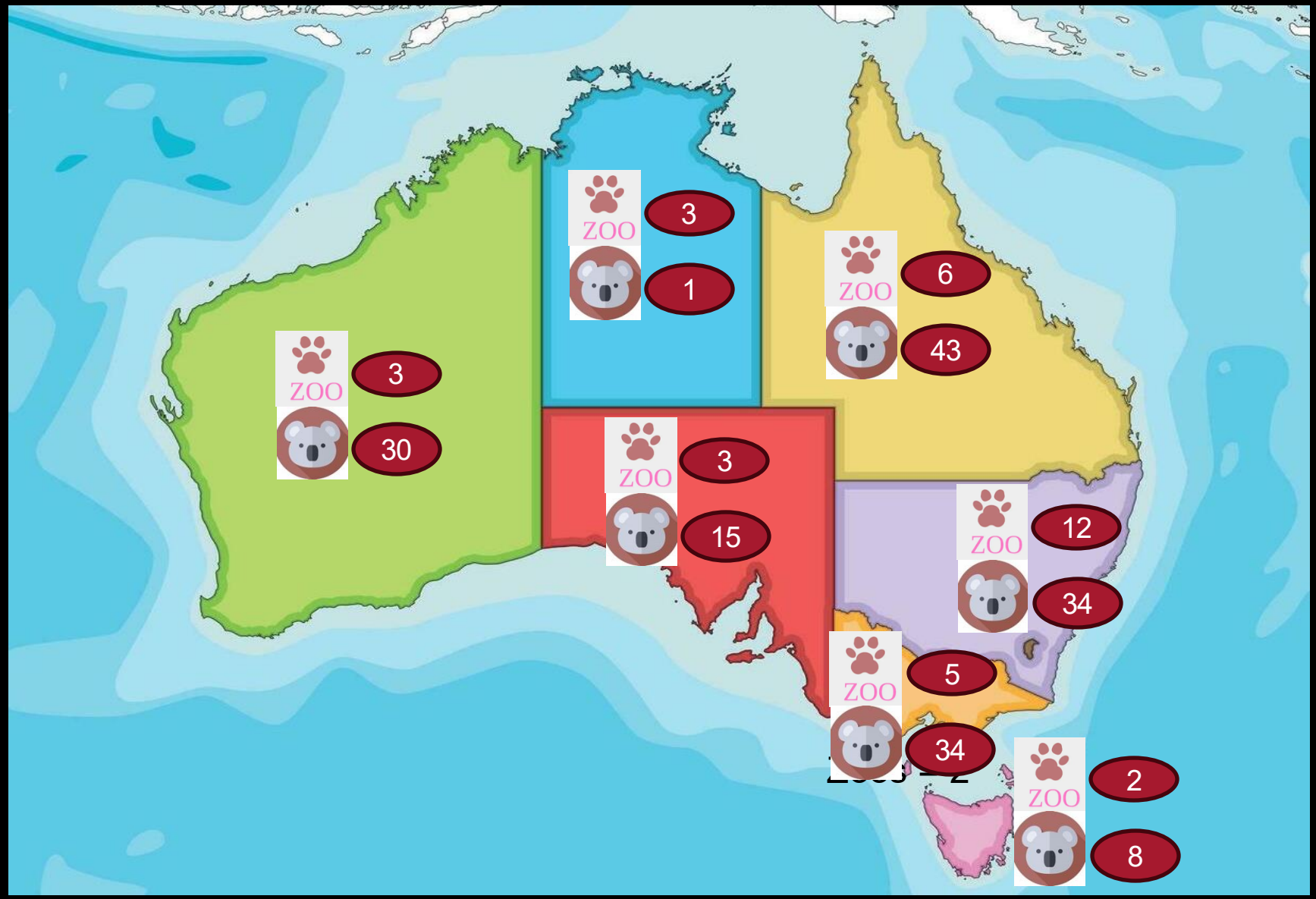
- Detected in diverse wildlife
  - Species representative of all major phyla
  - Land to the sea
  - Remote and urban areas

- Sentiments of AMR in wildlife
  - Naturally occurring
  - Antibiotics not used to treat wild animals
  - No impact for wildlife



Overlooks the significance of wildlife in AMR ecology, antimicrobial stewardship, and One Health

Australia's wildlife system – a snapshot!



NSW 2021-2022

NSW Department of Environment report

Wildlife rescues	A second chance	People power
128,262 native animals across **543** species rescued	**31,290** (24%) native animals released back to the wild	**8,621** volunteers

Wildlife Victoria - 2024

- 97,772 rescues
- 455 species

WIRES - 2025

- 163,776 rescues
- 460 carers

Investigating AMR in wildlife systems

MACQUARIE University
SYDNEY·AUSTRALIA

URBAN SETTINGS

Flying fox *Ngununy*

Possum *Wali*

Macropods *Badagarang*

CONSERVATION

Tasmanian devil *Purinina*

Platypus *Boondabarra*

Koala *Gula*

Echidna *Barrugin*

MARINE

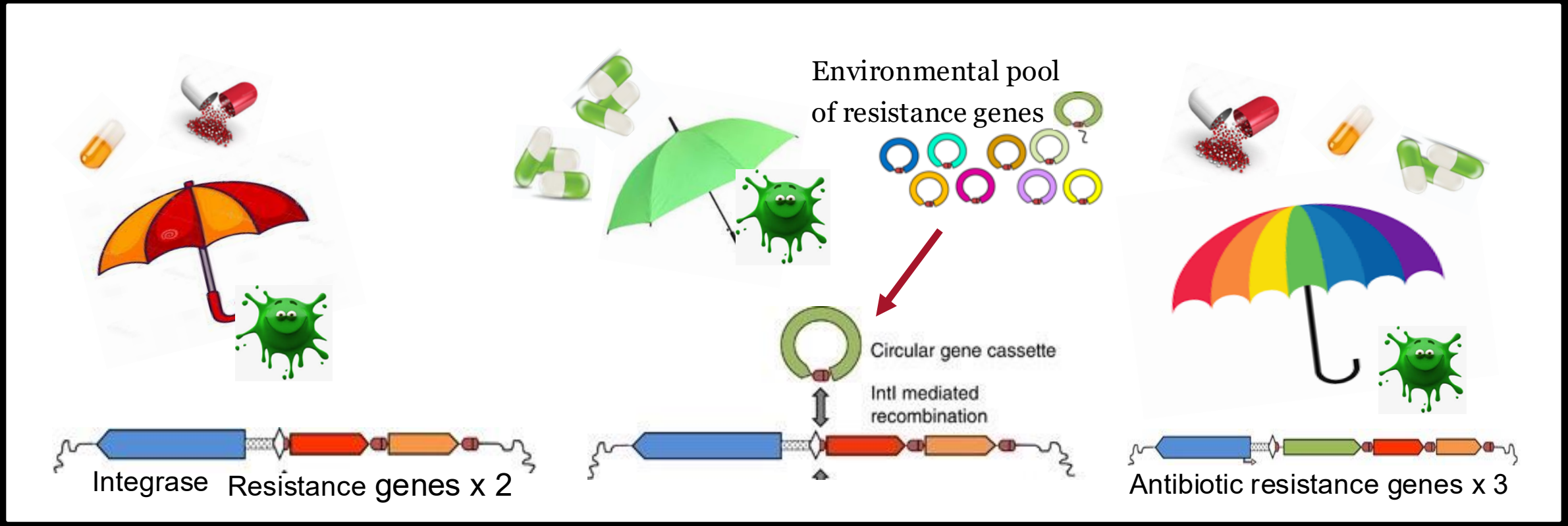
Australian sea lion *Bulgurra*

Little penguin *Gur-roo-mul*

Images: Echidna and Platypus Doug Gimesy; Sea lion - R Harcourt; Possum Stilgherrian Flickr creative commons 16251601655 ; Bat iStock; Others M Power

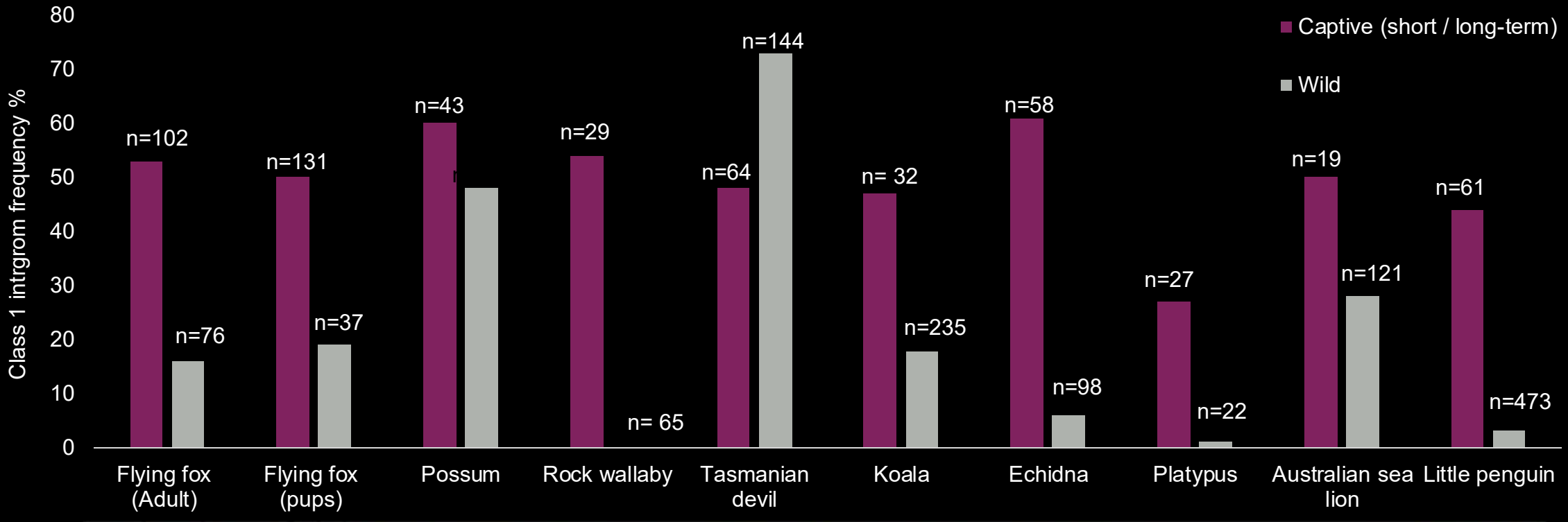
Anthropogenic origins | Clinical class 1 integron

- Assembled under antibiotic selection pressure 100 years ago
- Present in >80 clinically important bacterial species
- Proposed as an indicator of human pollution (Gillings 2015)



Anthropogenic origins | Clinical class 1 integron

Clinical class 1 integrons - more frequent in wildlife rehabilitation and in close-contact to people



Brushtail rock wallaby
Petrogale penicillata

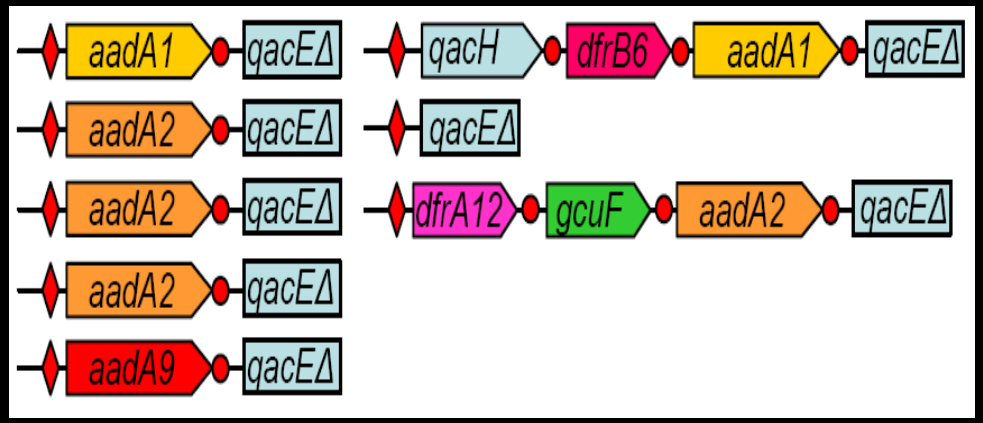
Photo Credit: Hugh McGregor

Conservation | dissemination risks

Endangered brush-tail rock wallabies (*Petrogale penicillate*):

- Class 1 integrons detected in 48% of captive-bred wallabies
- No class 1 integrons were detected in the wild population

https://www.mammalage.com



Post-release

- Risk spread of resistant bacteria to wild wallabies
- Dissemination into new environments

Power *et al.* 2013 *PLoS ONE* **8**: e63017

Koala
Phascolarctos cinereas

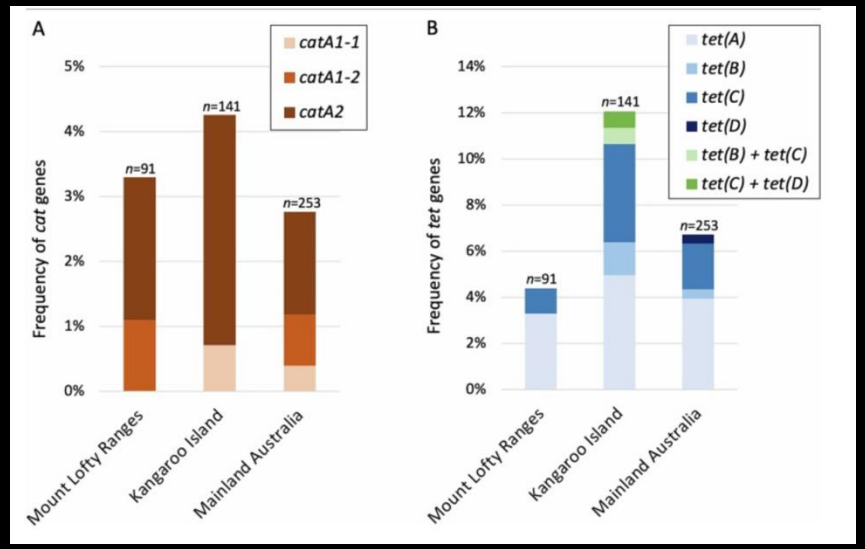
Gula

Conservation | antimicrobial reliance

Koala chlamydial disease treatments - Chloramphenicol and Doxycycline LA

- Resistance genes detected in koalas

- Co-infections with *Chlamydia pecorum* and resistant bacterial strains
- Potential for emergence of resistant *Chlamydia pecorum* strains - Non-resolving chlamydial disease and treatment failure
- Risk of secondary infections



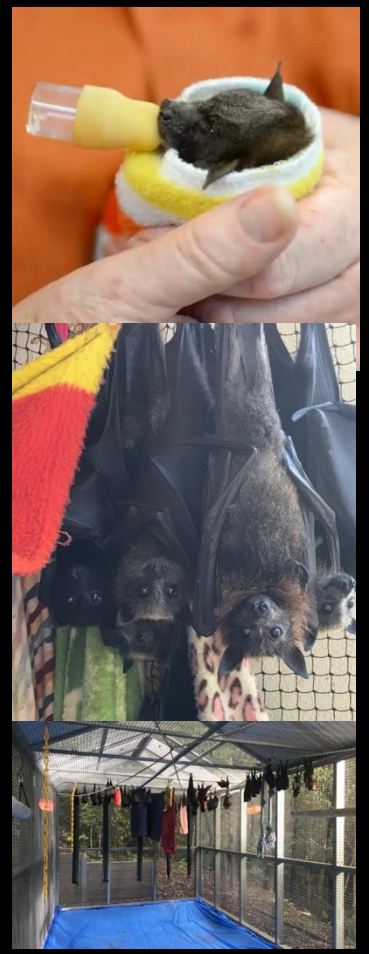
McDougall et al 2023 One Health

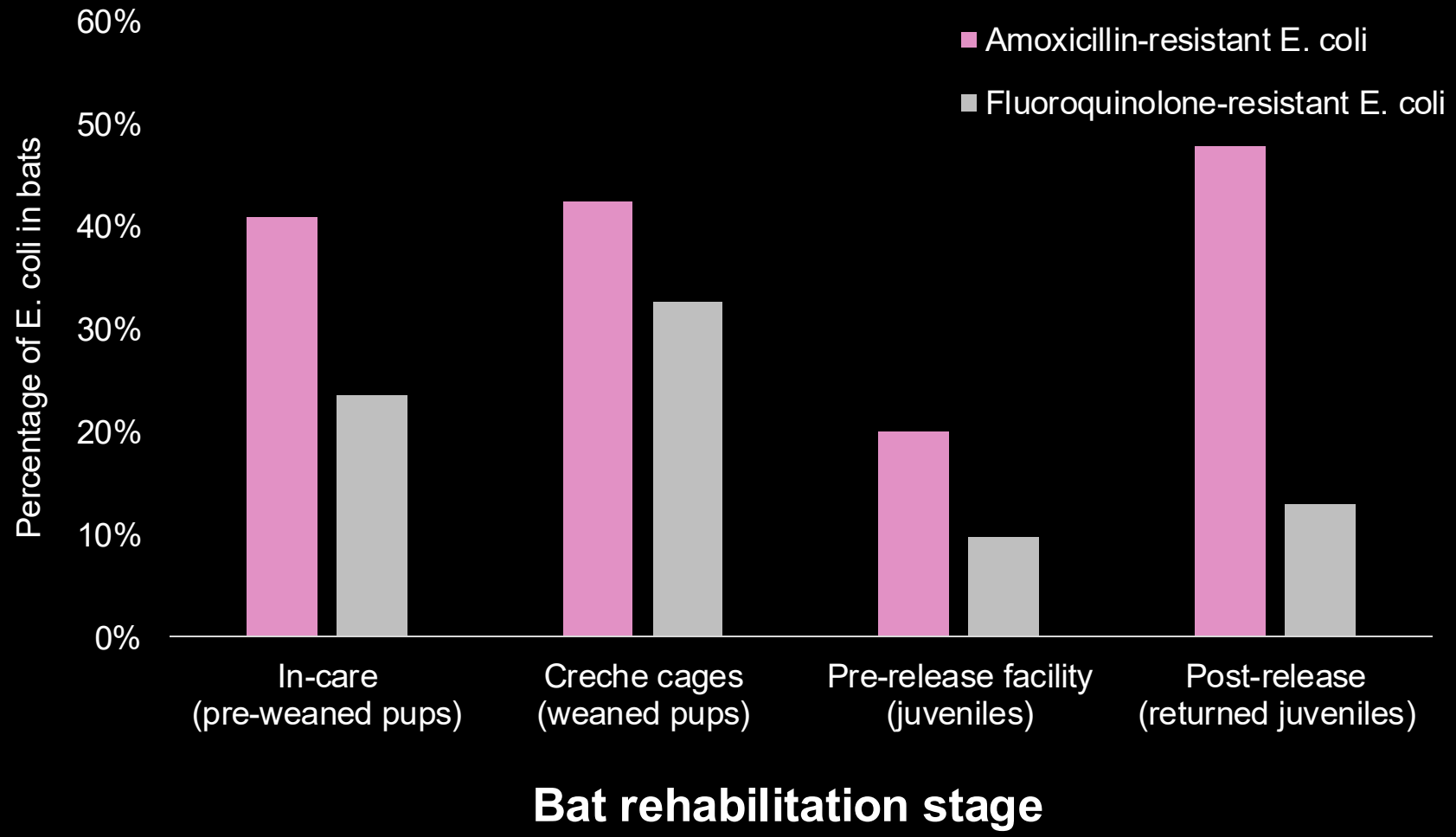
Grey headed flying fox
Pteropus poliocephalus

Ngununy

Image: Adam Mckeown

Wildlife rehabilitation | Antibiotic-resistant *E. coli*



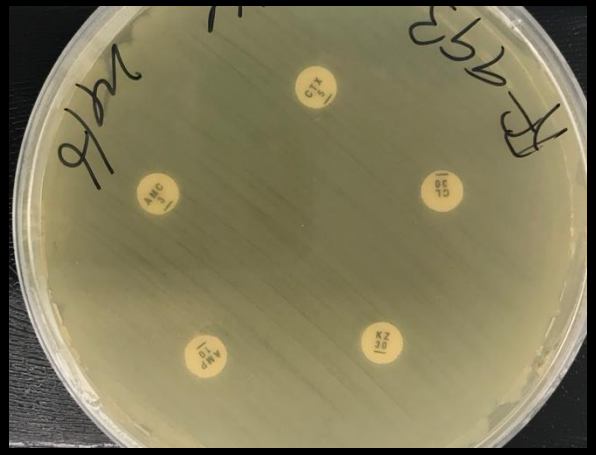


Wildlife rehabilitation | MDR, ESBL and carbapenem-resistant *E. coli*

48% *E. coli* isolates from bats multidrug-resistant

***E. coli* isolate FF1992A:**
*aph(3')-Ia, aph(6)-Id, aadA2, bla*SHV-12, *bla*TEM-1B, *dfrA14, dfrA19, qnrB2, qnrS1, sul1, sul2*

***E. coli* isolate FF2394:**
*aph(3'')-Ib, bla*CTX-M-15, *dfrA1, qnrS1, sul2, tet(A)*



4% ESBL-producing (*bla*CTX-M-15)

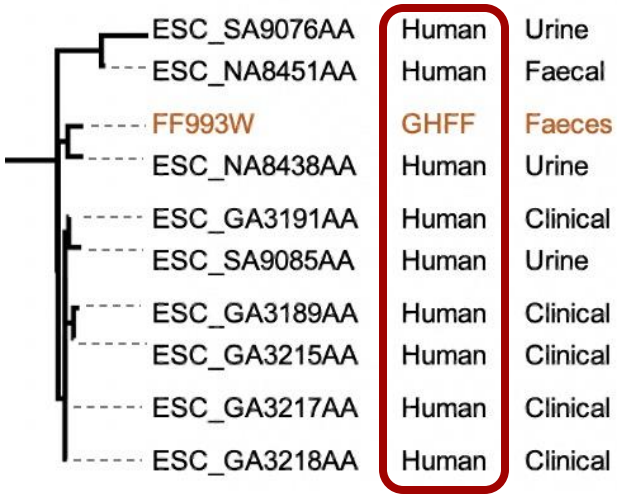
4% Carbapenem-resistant (*bla*OXA-23)

Anthropogenic origins | AMR *E. coli* in bats

>95% antibiotic-resistant *E. coli* strains from bats are lineages associated with humans and/or domestic animals

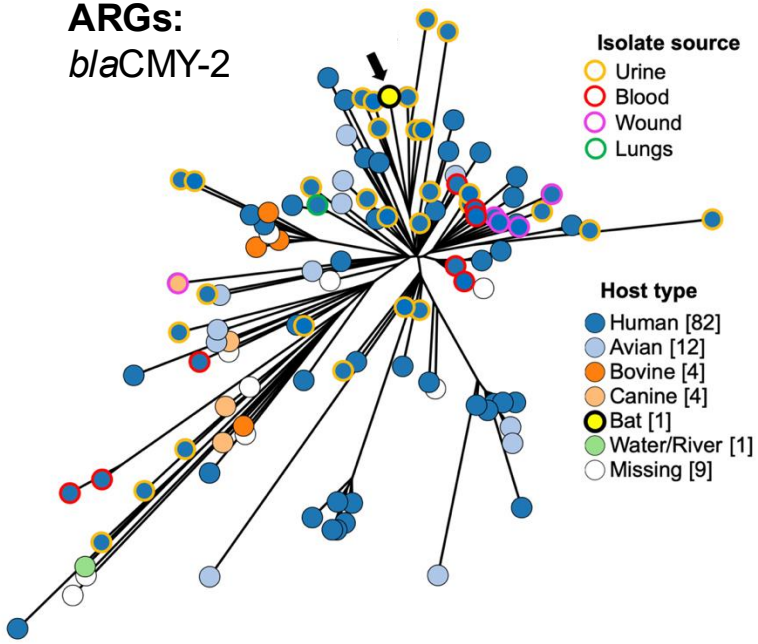
Bat *E. coli* isolate ST10 O89:H9

ARGs:
*bla*NDM-5
*bla*CTX-27
*bla*TEM-1B
catA2
dfrA14
gyrA/parC/parE
sul2
Tet(A)



Bat *E. coli* ST963 ONT:H18

ARGs:
*bla*CMY-2



Emergence risks | within host evolution

STRAIN EMERGENCE

E. coli ST38

Penicillins, chloramphenicol

↓

Penicillins, fluoroquinolones, chloramphenicol

E. coli ST131 Cx

Fluoroquinolones, trimethoprim

↓

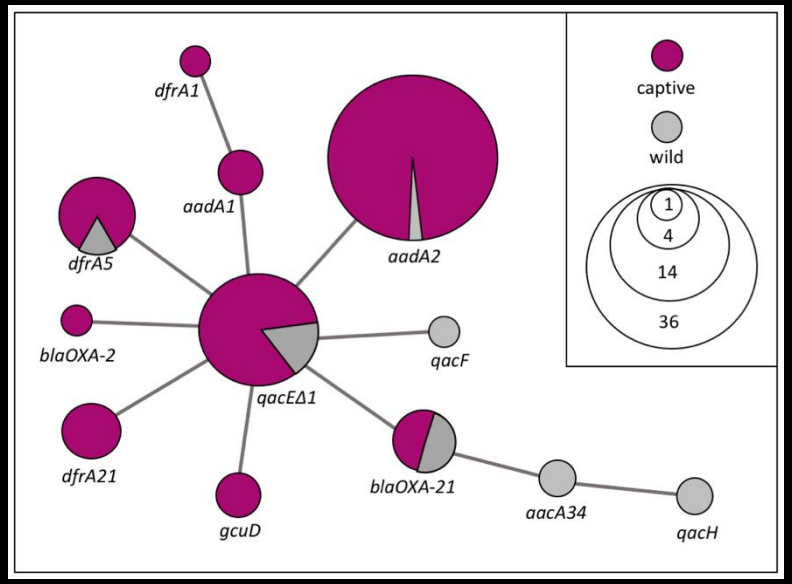
Penicillins, ESBL, fluoroquinolones, trimethoprim/sulfonamides, aminoglycosides

AMR DETRMINANT EMERGENCE

Novel clinical class 1 integrons

Novel clinical class 1 integrons and genes

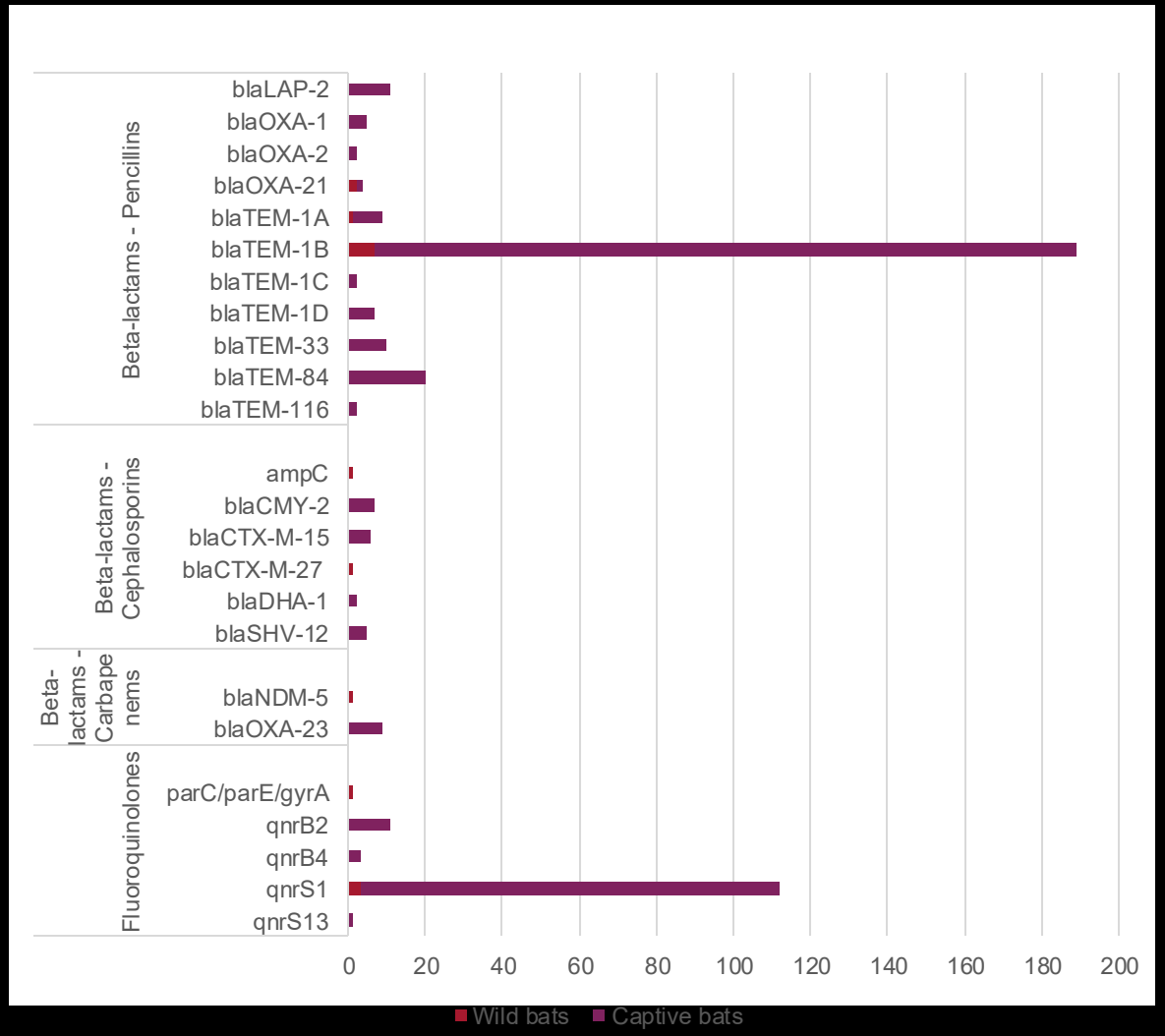
- *5′ CS-qacH-aacA34-bla*$_{OXA-21}$*3′CS*
- *5′CS-qacF-3′CS*



McDougall et al 2019 Infection, Genetics and Evolution

49 different antibiotic resistance genes in Grey-headed flying fox

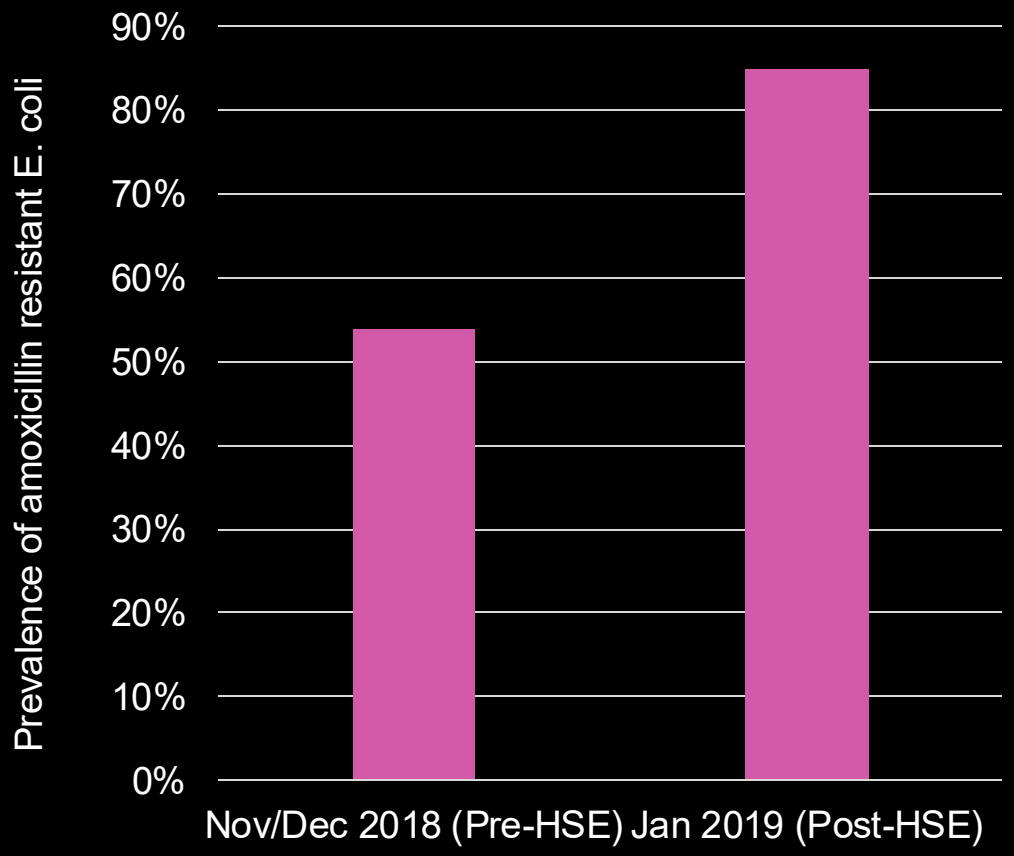
Antibiotic class	No. different ARGs
Beta lactams (penicillin ARGs)	11
Beta lactams – Cephalosporin ARGs	6
Beta lactams - Carbepenems	2
Aminoglycosides	9
Chloramphenicol	2
Tetracyclines	3
Fluoroquinolones	5
Sulfonamides/ trimethoprim	11
TOTAL	**49**

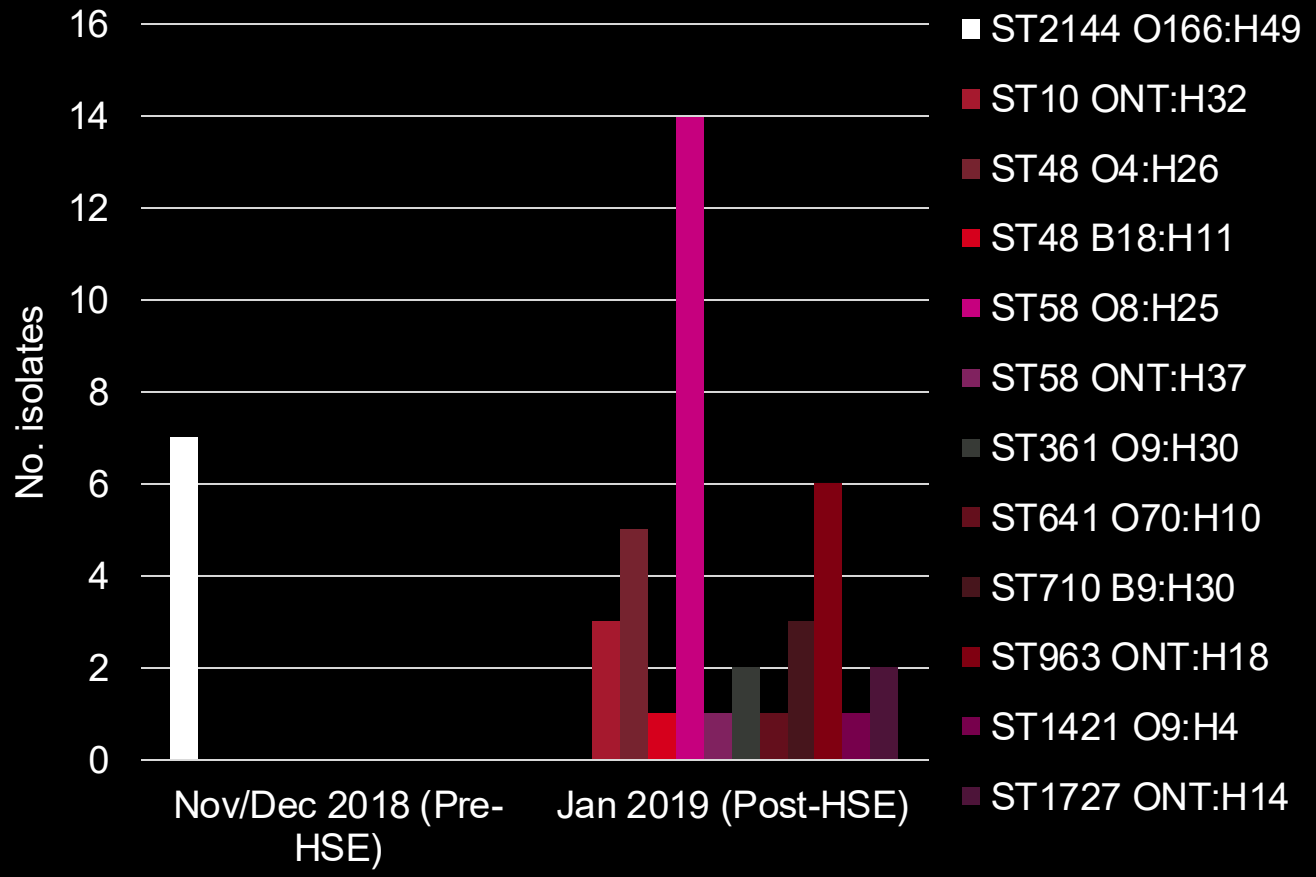


Wildlife emergencies

Anthropogenic impacts | AMR dynamics and heat stress in bats

Post heat stress bats - Increase in AMR *E. coli* and in diversity of strain types



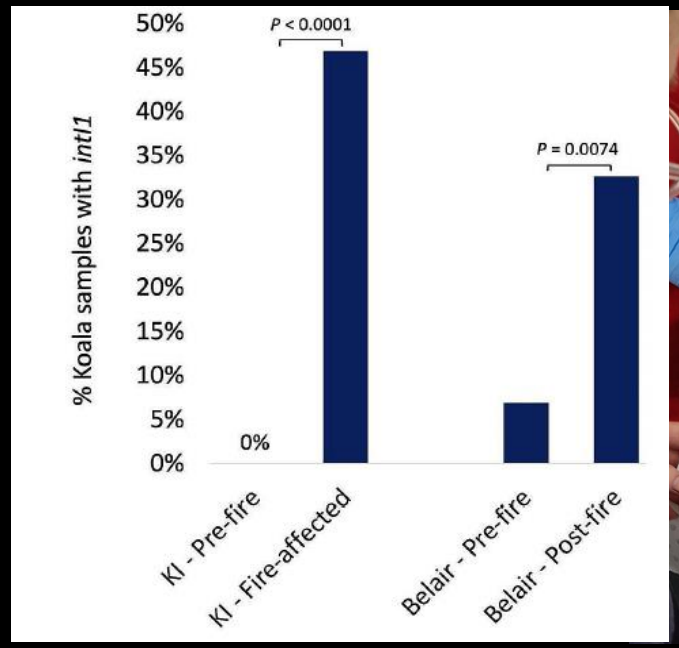


Anthropogenic impacts | AMR dynamics and fire

Class 1 integrons

Wild koalas sampled pre-fire (KI = 36, Bel = 32),

Post-fire (KI = 329 Bel = 98),

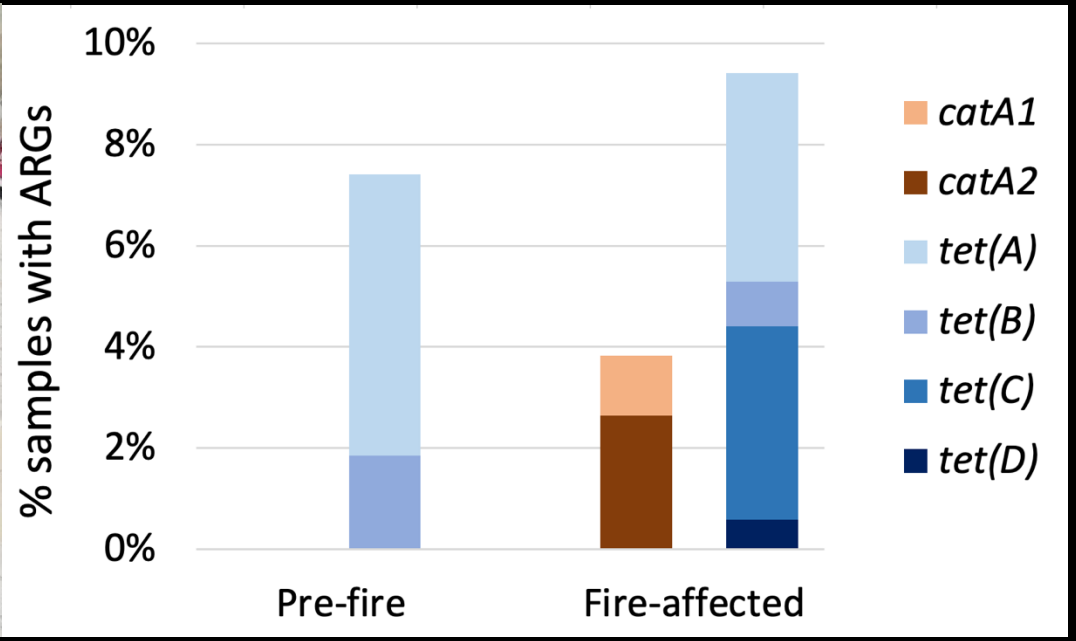


McDougall et al 2024 Microbial Ecology

Chloramphenicol and tetracycline

Wild koalas sampled pre-fire (n= 36)

Rehabilitation post-fire (n=95)



McDougall et al 2023 One Health

Anthropogenic impacts | Antimicrobial stewardship during wildlife emergencies

- Examined treatment records of 355 koalas admitted to wildlife hospitals during the 2019-2020 bushfires

Koala Hospital A

40.3% koalas received antibiotics

- 75.7% prophylactic treatment of non-infected cutaneous burns (penicillins, enrofloxacin)
- 23.6% for treatment of infections (penicillins, enrofloxacin)

Koala Hospital B

35.0% koalas received antibiotics

- 18.8% prophylactic treatment of non-infected cutaneous burns (penicillins)
- 81.2% for chlamydial disease & other infections (chloramphenicol, enrofloxacin and amoxicillin)

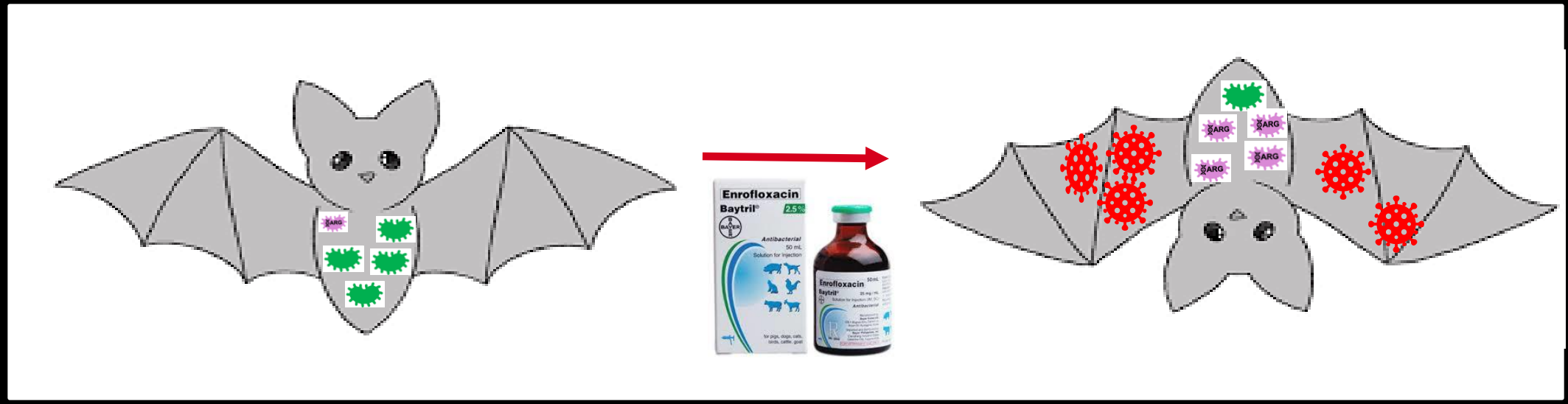
Anthropogenic impacts | ongoing selection

Good gut bacteria

ARG

Resistant bacteria

Resistant secondary infections



Gammaretroviruses, novel viruses and pathogenic bacteria in Australian bats with neurological signs, pneumonia and skin lesions

Kate Van Brussel [a], Jackie E. Mahar [a], Jane Hall [b], Hannah Bender [b], Ayda Susana Ortiz-Baez [a], Wei-Shan Chang [a], Edward C. Holmes [a,*], Karrie Rose [b,**]

[a] Sydney Institute for Infectious Diseases, School of Medical Sciences, The University of Sydney, NSW, 2006, Australia
[b] Australian Registry of Wildlife Health, Taronga Conservation Society Australia, Mosman, New South Wales, Australia

Nadine Samy - Master research

- Data mining from wildlife pathogen database
- 55% of the *Pseudomonas aeruginosa* strains from these bats were resistant to enrofloxacin
- We do not know if the bats received enrofloxacin.

Antimicrobial Stewardship and wildlife

AMR HAS NO SPECIES BOUNDARIES

Key points

- Wildlife species have acquired AMR strains from anthropogenic sources
- Antibiotics are used to treat wild animals
- Knowledge of AMR ecology, drivers, and stewardship required for the wildlife health sector

Translation of research findings

- Using wildlife AMR data to education wildlife care groups on AMR and AMS
- Establishing an AMS Action plan for wildlife (CSIRO, WHA and ZAA, wildlife experts representing One Health)

QUESTIONS

Image N. Edards, link CC-BY-NC-ND