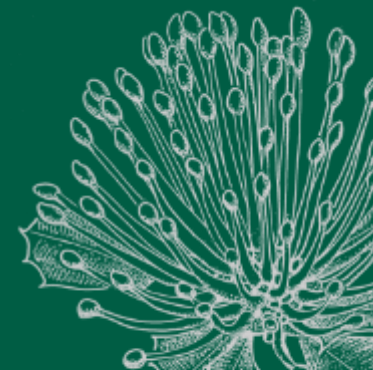




Picasso, 1939  
Cat catching a bird

Sarah Legge,  
John Woinarski,  
Brett Murphy,  
Stephen Garnett,  
Sarah Comer,  
Chris Dickman,  
Tim Doherty,  
Glenn Edwards,  
Alex Nankivell,  
Russell Palmer,  
David Paton,  
Leigh-Ann Woolley



# Cats and the conservation of Australian birds

# Context

## Cat impacts on Australian mammals established

- 30+ taxa extinct; 35% of all global mammalian extinctions since 1500
- Cats main driver for about two-thirds, exacerbated by habitat change from fire, grazing, other ferals (eg. rabbits)
- Still causing declines in extant taxa



Impacts on Australian birds? Less clear, with no systematic review.

## Objective

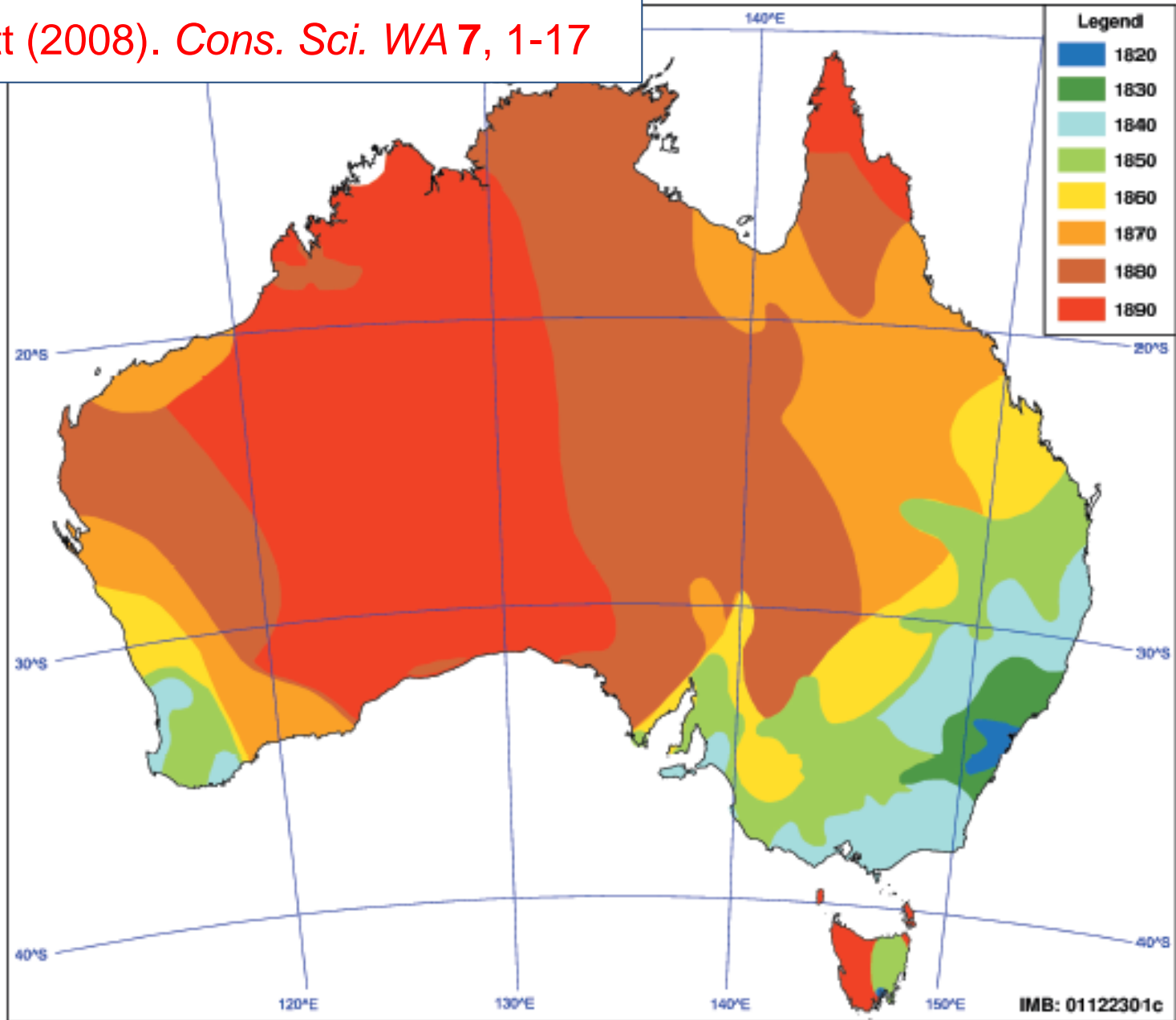
Assess impacts of cats on Australian birds

Cat catching ducks; 1<sup>st</sup> C BC; Smithsonian



# Spread of cat in Australia

from Abbott (2008). *Cons. Sci. WA* 7, 1-17



# First Australian bird extinctions due to cats

2 endemic subsp, Macquarie Is  
extinct in 1890s (buff-banded rail,  
red-fronted parakeet)

- Cats established by 1820
- Rabbits introduced 1879, led to increase in cats



Taylor RH (1979) How the Macquarie Island parakeet became extinct. *New Zealand Journal of Ecology* 2, 42-45

# Early ornithologists were aware of the broader threat

## Campbell 1906:

“Undoubtedly, if many of our highly interesting and beautiful birds, especially ground-loving species, are to be preserved from total extinction, we must as a bird-lovers’ union, at no distant date face squarely a wild-cat destruction scheme”



Ashby (1924): “the domesticated cats, that have become wild, and are now very numerous, have, as it appears, nearly exterminated [the ground parrot] in their old retreats”



Whitlock (1924): “Whatever may be said to the contrary, cats (domestic gone wild) are accountable for the disappearance of this rare species in some quarters ... the birds disappeared after an invasion of cats”



Ashby E (1924b) Notes on extinct or rare Australian birds, with suggestions as to some of the causes of their disappearance. Part II. *Emu* **23**, 294-298.

Whitlock FL (1924) Journey to Central Australia in search of the Night Parrot. *Emu* **23**, 248-281]

# Early quantitative studies reached divergent conclusions

## Macquarie Is

- ca. 375 cats on 130 km<sup>2</sup> island,
- 47,000 Antarctic prions & 11,000 white-headed petrels per year
- 154 birds/cat /year, or
- 443 birds/km/year

Jones E (1977) Ecology of the feral cat, *Felis catus* on Macquarie Island. *Australian Wildlife Research* **4**, 249-262

## SE Australia

- 128 feral cat stomachs
- birds found in only **7.5%** of samples

“The common belief that feral cats are serious predators of birds is apparently without basis. Although birds were common in all sampling areas, they were a relatively minor item in the diet [of cats].”

Coman & Brunner (1972). Food habits of the feral house cat in Victoria. *Journal of Wildlife Management* **36**, 848-853.

# How many birds are killed by cats?

1. How many cats are there?

2. How many birds does a cat kill?

- Feral cats / pet cats
- Spatio-temporal variation

What makes a bird more likely to be killed by a cat?





# 1. How many cats are there?

## Cat distribution

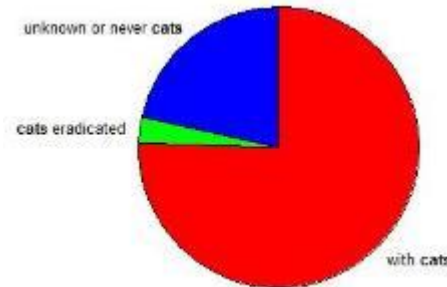
### Mainland fenced areas

- Containing 'wild' populations of threatened mammals
- 18 each 0.05-78 km<sup>2</sup>
- **Total = 309 km<sup>2</sup>; < 0.004% of Australia**



### Islands

- Absent on 592 (4,911 km<sup>2</sup>)
- Unknown on 4,758 > 1 ha; (2,535 km<sup>2</sup>)
- **Total = 4,911-7,446 km<sup>2</sup>; 0.06- 0.1% of Australia**



**Cats absent << 0.2% of Australia**

# In the 99.8% of Australia with feral cats...

Population estimates for cats in:

1. Natural environments

2. Heavily modified environments



*H. McGregor/NESP TSR Hub, Arid Recovery*



*All About Anything*



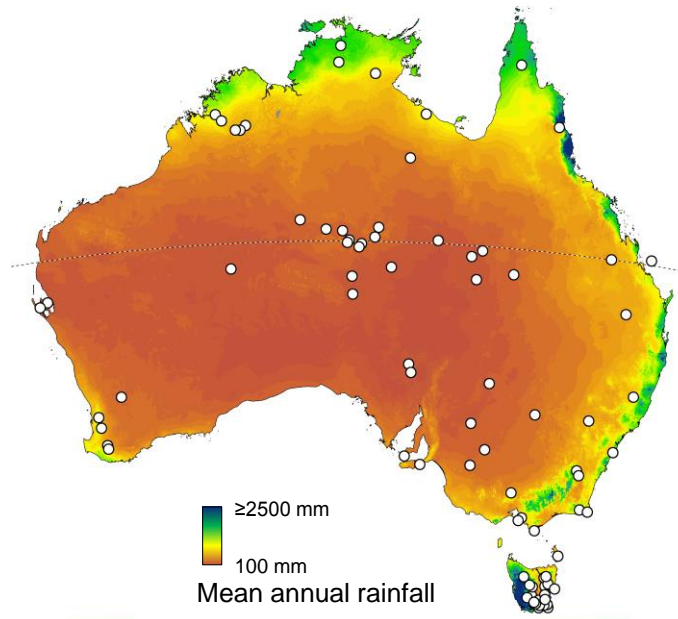
# Feral cats in natural environments

## Site-based density estimates

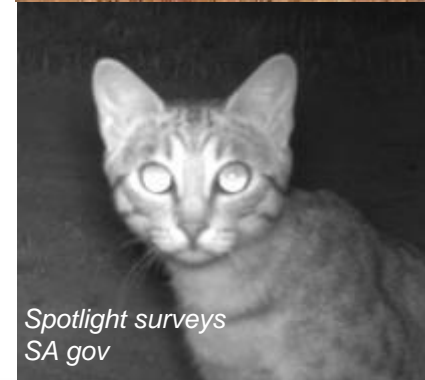
- 78 from mainland & Tassie
- 13 on islands

## Modelled variation vs

- mainland/island
- mean annual rainfall
- mean annual temperature
- tree cover
- ruggedness
- fox presence
- conservation land use (or not)



Removal  
<http://bushwalk.com/>



Spotlight surveys  
SA gov



Radiotracking

L.Brook/JCU

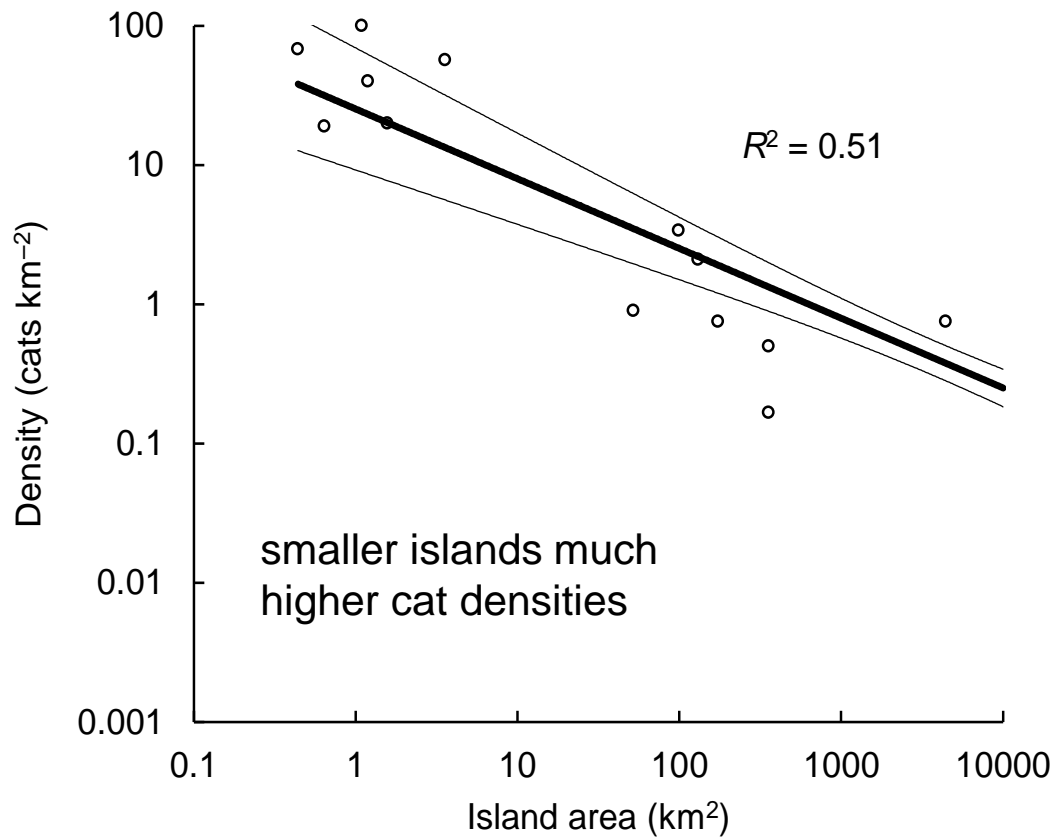


Camera Trapping  
Billy Ross/NESP TSR Hub



# Cat density is higher on islands

mainland/island



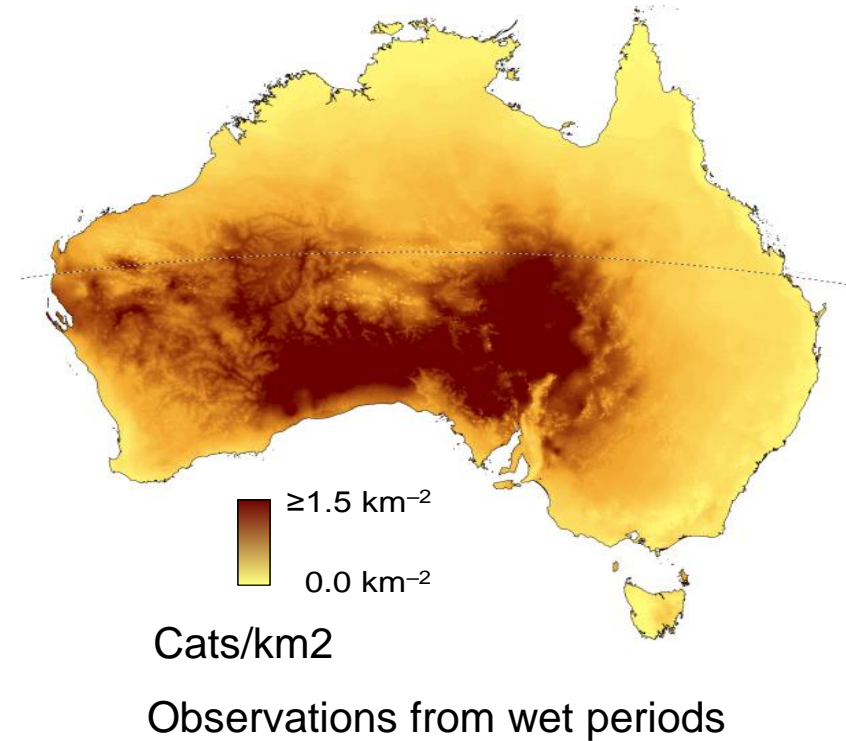
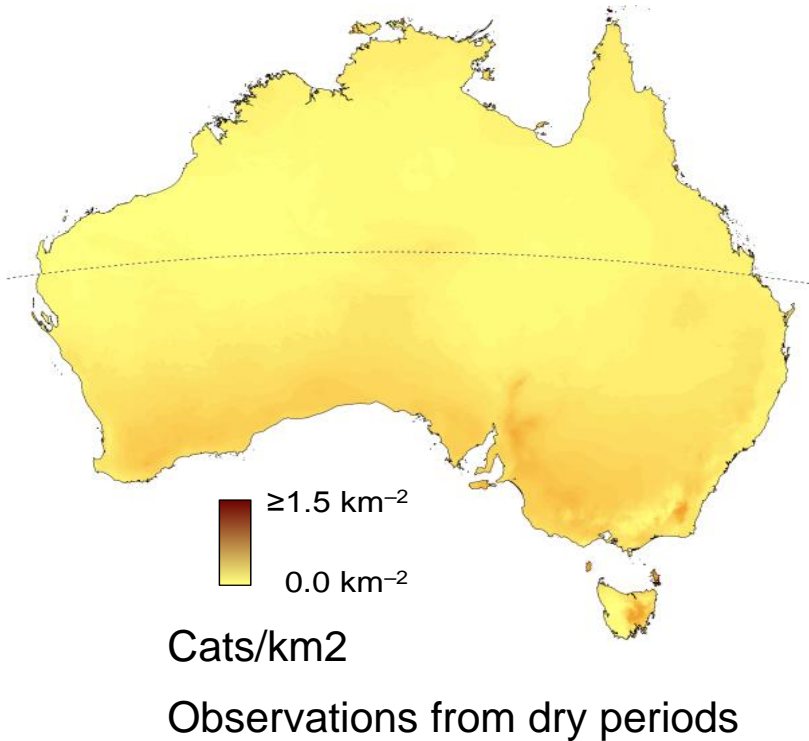
The good life:

- Seabird colonies
- Shoreline flotsam
- No larger predators





# Cat density is higher in low rainfall areas, but only after extensive rain



Cat population fluctuates between 1.6 (dry) to 5.6 (wet)  
Density fluctuates between 0.18 to 0.73 cats km<sup>-2</sup>



# Feral cats in heavily modified environments

Different approach to estimation

1. Fewer data available
2. Density hyper-variable, depends on extent of food subsidy:



High density because of intro spp, scavenging opps, etc



Plus COLONIES at sites with rich food subsidies (dumps, farms, etc)

Reuters/Daily Mail

A Santiago

# Feral cats in heavily modified environments

- Background density of feral cats = 8.2 cats/km<sup>2</sup> (range: 0.8–32 cats km<sup>-2</sup>)
- Australia's heavily modified environments cover 54,713 km<sup>2</sup> (each from 0.02-2543 km<sup>2</sup>)

PLUS

- 10,370 sites that could support cat colonies (mean site size = 0.22 km<sup>2</sup>; range 0.003-3.16 km<sup>2</sup>)
- Mean colony size = 26 (min/max range: 3-81)



**Total number of cats = 723,300 (range 0.08 - 2.6 million)**

# 1. How many cats are there?

## **Natural environments:**

Fluctuates from 1.4 million (in drought) to 5.6 million (wet conditions)

## **Heavily modified environments:**

Over 0.7 million

## **PLUS Domestic cats:**

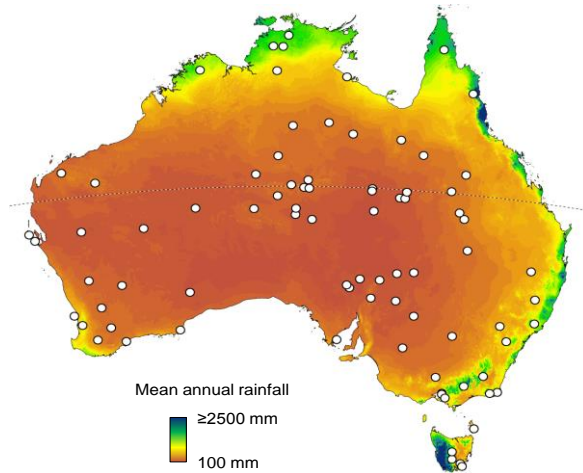
3.9 million (from household surveys)





## 2. How many birds does a cat kill?

Collated >90 cat diet studies  
(c.10,000 cat stomachs, scats)



The number of birds killed =

Cat density

x

% diet samples that have birds

x

n. birds per diet sample



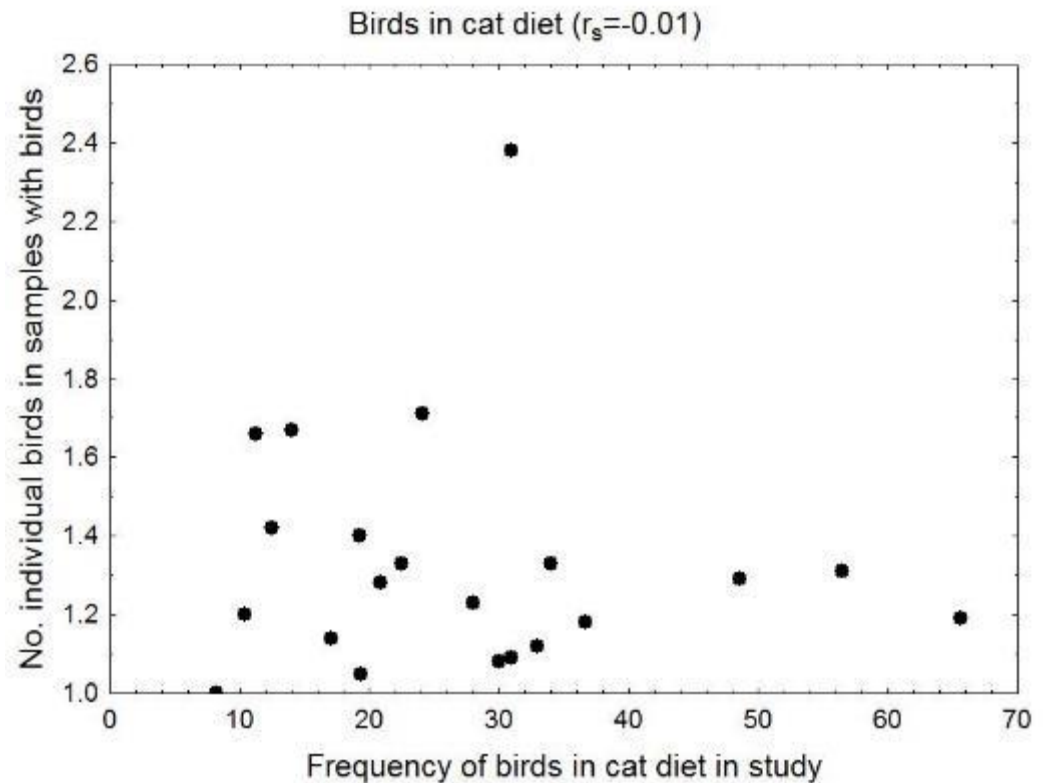
Greg Wilson 2016. feral cat, kitten,  
with stomach contents

We got kitten here, cat, pussy cat,  
... Feral cats... they killing all the  
goanna, all the bird, and the  
possum. ...First Captain something,  
Captain Cook, he's the one, he  
made the mess, mucked up this  
country. ... They don't belong here.  
Get rid of them. This country belong  
to kangaroo and emu and brolga.  
Not cat or cane toad or buffalo

# Number of birds per diet sample

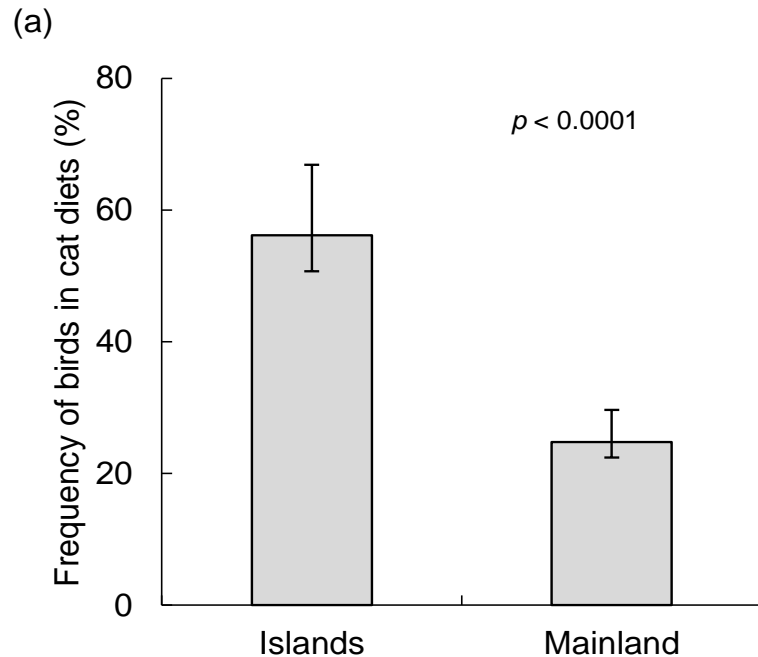


- N. birds in cat samples that had birds: **1.34**
- Unrelated to % of cat diet samples that had birds

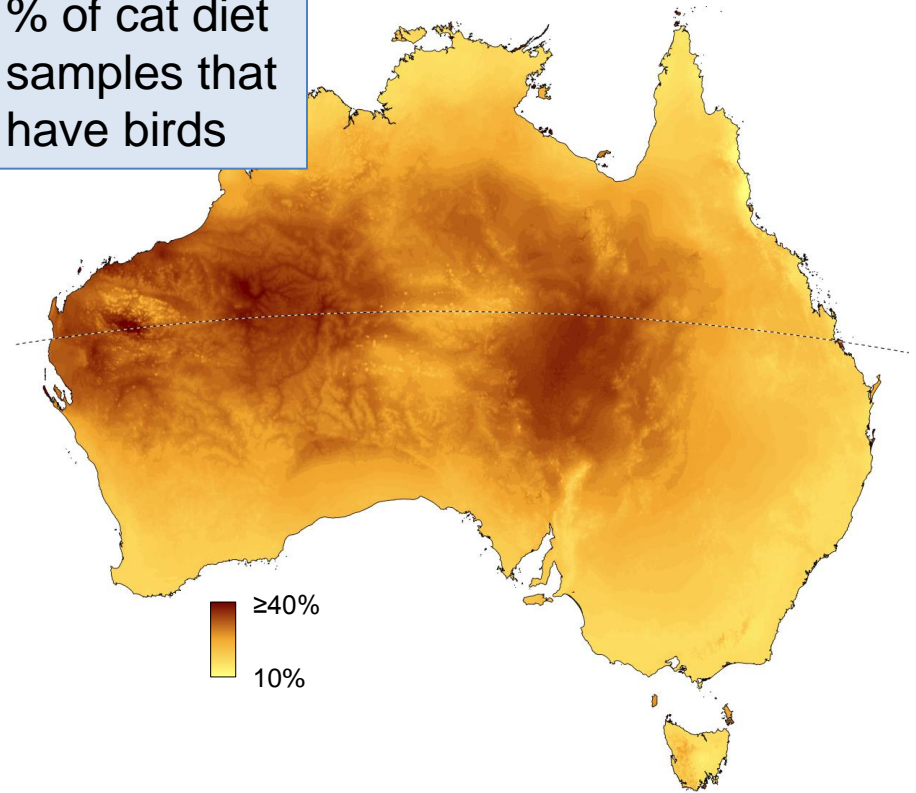


# % of diet samples that have birds

- 31.6% (95% CI 26.4-36.7%)
- % varies with island size and mean annual rainfall



% of cat diet samples that have birds



# Birds killed by feral cats in natural environments



Islands:

107 birds/km<sup>2</sup>/yr

18 birds/km<sup>2</sup>/yr

Each cat kills 129 birds/yr

Total of 272 million birds/yr

(Fluctuating 161-757 million in dry-wet periods)

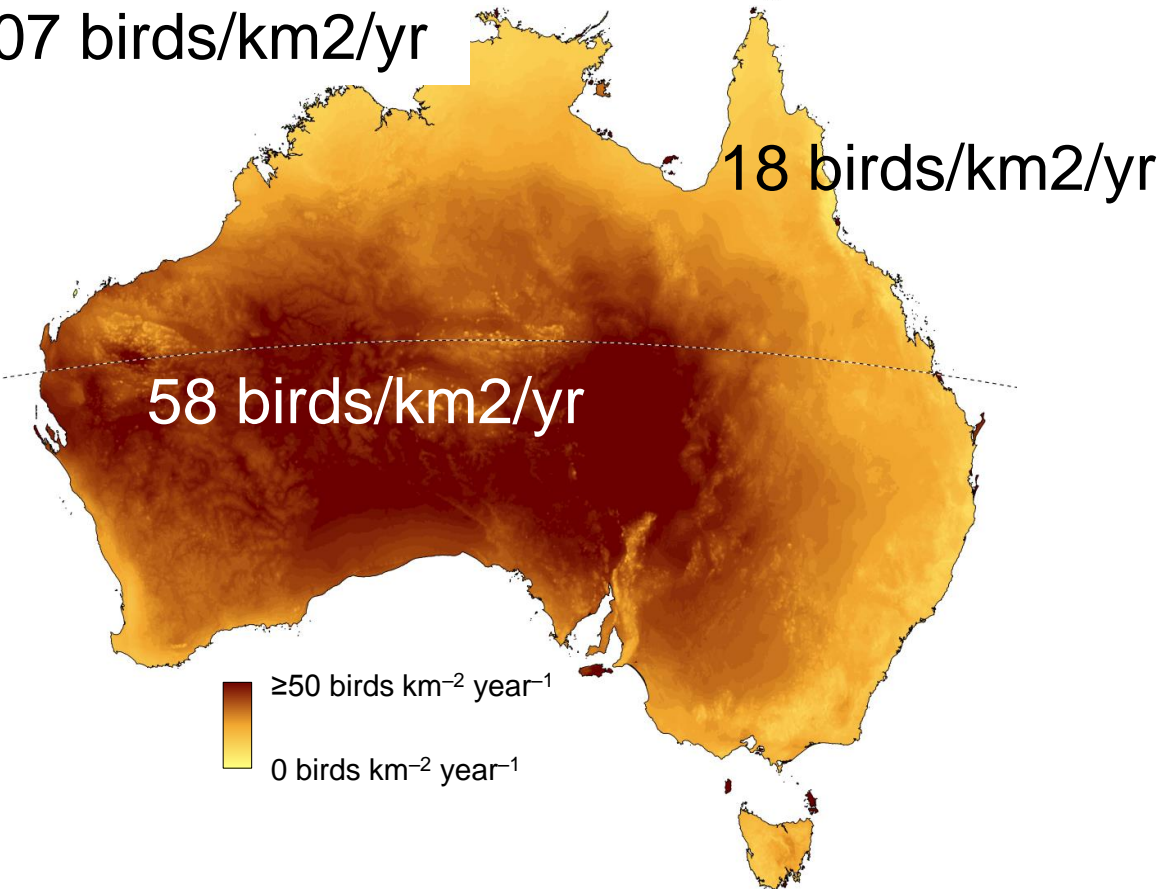
>99% of these killed birds are native

Islands:

- Seabird colonies
- No alternative prey
- Birds may be predator-naïve

Arid:

- Sparser, lower vegetation



Average n birds eaten by cats/km<sup>2</sup>/yr = 35.6  
(21-99 in dry-wet periods)

## Feral cats in highly modified environments (suburbs, rubbish dumps)



- % cat diet samples with birds = 14.4%  
(instead of 31.6% for bush ferals)
- Each cat kills 62 birds/year
- Given there are 0.7 million cats, overall =  
44 million birds/year

# Pet cats



**3.9 million** pet cats take home a mean of **4.5 birds/year**

- From studies of owners reporting what pet cats bring home (> 1000 cats, three Australian cities)

BUT pet cats only bring home **29% of their kills** (13-50%)

Average pet cat kills = **16 birds/yr**

All pet cats kill  $16 \times 3.9 \text{ m} =$  **61.6 million birds/yr**

# Numbers of Australian birds killed by cats

Cats	Pop size	Bird take
Ferals in natural env	2.1 million	272 million (99% native)
Ferals in modified env	0.7 million	44 million
Pets	3.9 million	61 million (80% native)
<b>total</b>	<b>6.7 million</b>	<b>377 million</b>



Picasso, 1939, Cat catching a bird

- **> 1 million birds a day**
- If cats kill 35.6 birds km<sup>2</sup>/year and 377 million birds/year, how big a bite is that?

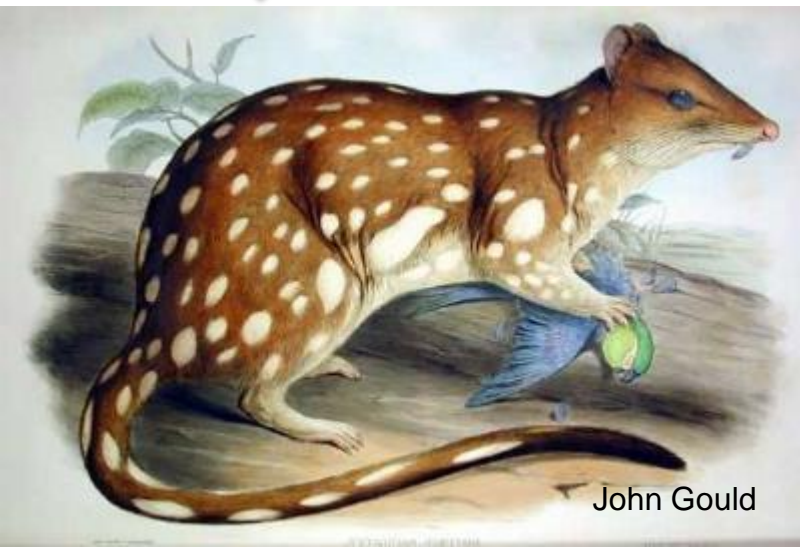
# Cats compared to other mammalian predators



29% vs 17%  
(22 studies)



23% vs 9%  
(2 studies)



34% vs 14%  
(15 studies)





# Numbers of Australian birds killed by cats

- > 1 million birds a day
- 35.6 birds km<sup>2</sup>/year



Cat, blue-winged kookaburra. J. Heathcote

## How big a bite is that?

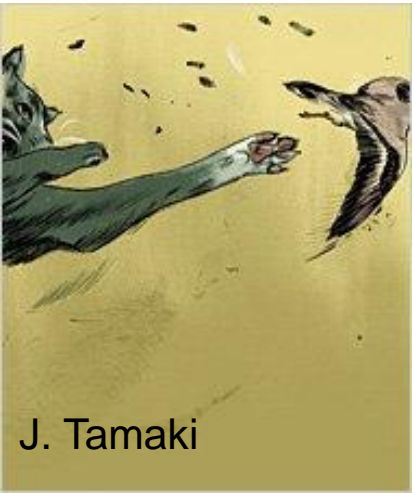
- No estimate of the no. of birds in Australia
- Typical density of birds in terrestrial habitats are 5-30 birds/ha; or ca. 10 billion birds;
- Annual take of birds by cats is ~ 3-4% of Australia's land birds

# How many birds are killed by cats?

A close-up photograph of a tabby cat with green eyes walking through a field of dry leaves and twigs. The cat is looking directly at the camera with a focused expression. The background is filled with natural debris, creating a textured and somewhat chaotic environment.

1. How many cats are there?
2. How many birds does a cat kill?
  - Feral cats / pet cats
  - Spatio-temporal variation

What makes a bird more likely to be killed by a cat?

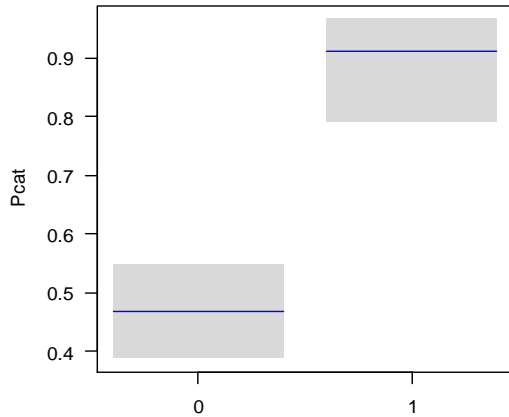


# What makes a bird more likely to be killed by a cat?

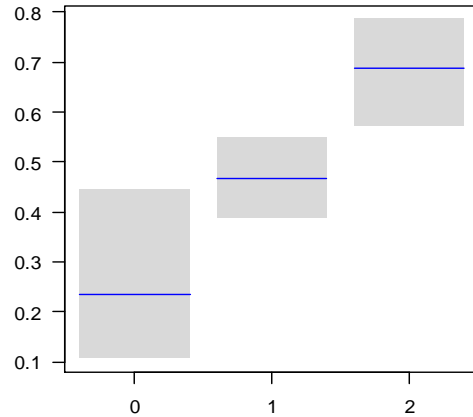
- Searched literature, bird-banding databases, museum specimen records, summaries of vet. databases for records of cats killing Australian bird species
- Records for 338 native bird species (46% of all Australian bird species)
- Includes 71 bird species listed as threatened under EPBC Act (61% of 117 listed bird species)

species not recorded as cat-killed were mostly very large birds, visiting shorebirds, seabirds, rainforest birds, and species with small remote ranges in which there have been few studies

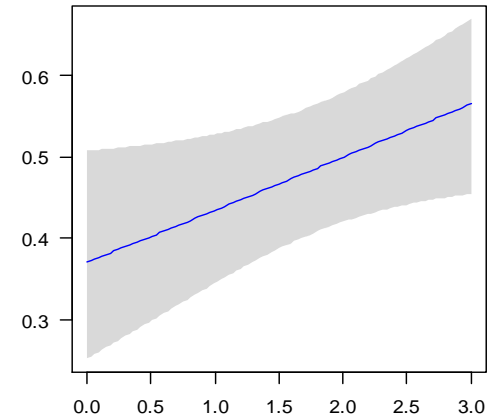
# What makes a bird more likely to be killed by a cat?



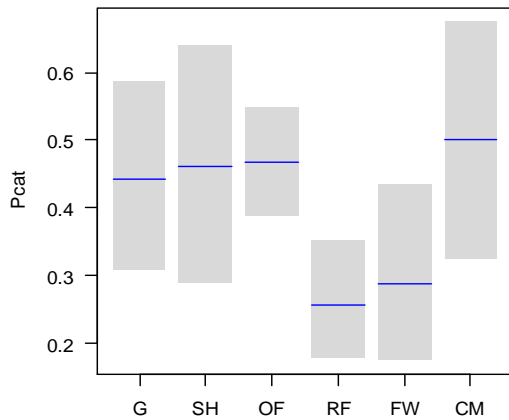
island



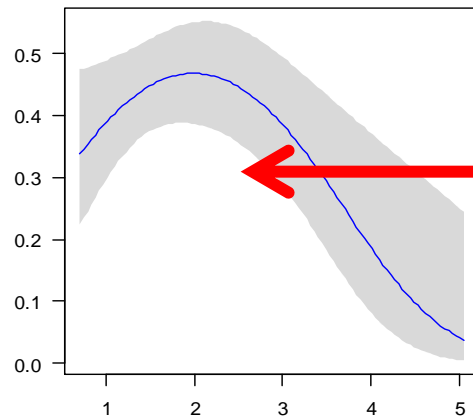
ground-nesting



ground-foraging



habitat



log (body weight)

60-300 g

# What makes a bird more likely to be killed by a cat?

Common name	$P_{\text{cat}}$
Australian Magpie	0.90
Masked Lapwing	0.89
Australasian Pipit	0.89
Common Blackbird	0.88
Magpie-lark	0.87
Superb Fairy-wren	0.87
Galah	0.87
Laughing Kookaburra	0.87
Yellow-rumped Thornbill	0.87
Rock Dove	0.86
Silver Gull	0.86
White-browed Scrubwren	0.85
Striated Pardalote	0.84
Crested Pigeon	0.84
Rufous Songlark	0.83
Eurasian Skylark	0.83
Grey Shrike-thrush	0.83

Predicted values from model averaging (probability relative to other spp)

Widespread and common species that forage/nest on/near the ground

**Control for distributional extent & 'abundance'**

Sum of observations in Atlases and number of birds banded

# What makes a bird more likely to be killed by a cat?

Per capita (controlling for abundance/distribution)

Spotted Quail-thrush	0.79	Western Ground Parrot	0.76
Chestnut-backed Button-quail	0.79	Eastern Ground Parrot	0.76
Painted Button-quail	0.79	Rufous Bristlebird	0.76
Buff-breasted Button-quail	0.79	Crested Bellbird	0.76
White-quilled Rock-Pigeon	0.79	Superb Lyrebird	0.76
Chestnut-quilled Rock-Pigeon	0.79	Western Whipbird	0.76
Partridge Pigeon	0.78	Eastern Bristlebird	0.75
Brush Bronzewing	0.78	Noisy Scrub-bird	0.75
Squatter Pigeon	0.78	Chirruping Wedgebill	0.75
Sandstone Shrike-thrush	0.78	Chiming Wedgebill	0.75
Red-backed Kingfisher	0.78	Stubble Quail	0.75
Chestnut Quail-thrush	0.78	Brown Quail	0.75
Chestnut-breasted Quail-thrush	0.78	California Quail	0.75
Rufous Scrub-bird	0.78	Inland Dotterel	0.75
Paradise Parrot	0.78	Banded Lapwing	0.75
Cinnamon Quail-thrush	0.78	Night Parrot	0.75
Rufous Songlark	0.77	White-bellied Spinifex Pigeon	0.75
Southern Scrub-robin	0.77	Pilbara Spinifex Pigeon	0.75
Bush Stone-curlew	0.77	Western Bristlebird	0.75
Common Blackbird	0.77	Plains-wanderer	0.75

# Conservation impact or just consumption?

- Huge numbers of birds being killed by cats
- Especially in arid zone and islands
- Some species more affected than others



Jilian Tamaki

1. Targeted research
2. Management options

# Targeted research

## 1. Improve cat control methods



If only it were this easy??

## 2. Quantify mortality impacts on bird species

- Focal species predicted to be most cat-susceptible (e.g. quail-thrushes, button-quails, bronzewings, etc).
- Assess mortality factors, and incorporate into PVA



## BACI contrasts

### Cat/fox free fenced areas

- 18 exclosures with total area of 346 km<sup>2</sup> (largest 123 km<sup>2</sup>)

### Cat/fox free islands

- Some bird translocations involved

### Cat/fox controlled areas

- Techniques to assess cat densities improved





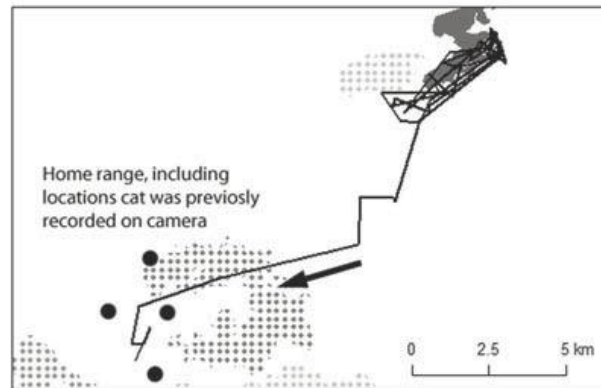
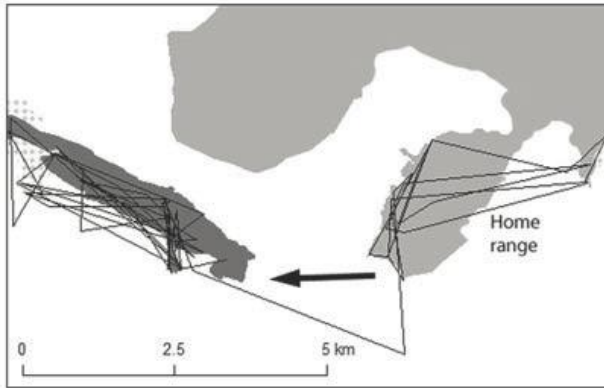
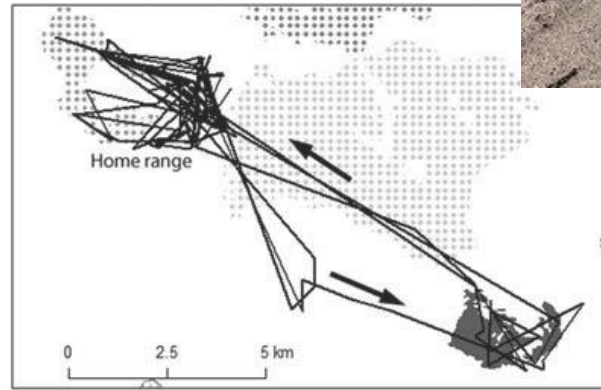
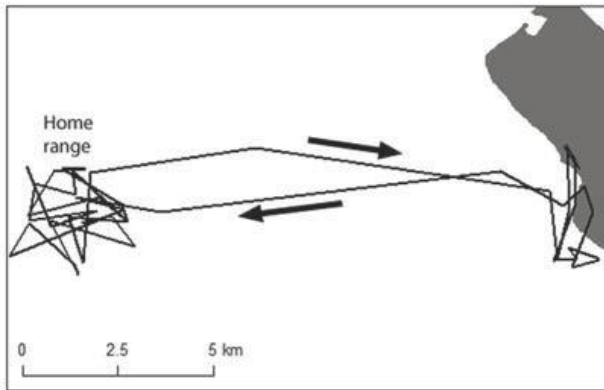
# Targeted research....(cont)

3. Interactions between cats and other threats (fire, habitat fragmentation/degradation, livestock-grazing)



# Feral cats interact with fire

Cats hunt in intense fire scars inside their own territories AND Cats also travel OUTSIDE their territories to visit areas burnt in intense fires



- Intense fire scar < 3 months old
- Intense fire scar 4 to 9 months old
- Mild fire scar < 12 months old

McGregor, Legge, Jones, Johnson (2016) Scientific reports

Mortality risk  
increased > 20 fold  
after intense fire



*McGregor, Legge, Jones, Johnson  
(2015) Plos ONE  
Leahy, Legge, Tuft et al 2016 Wildlife  
Research*

# Management options

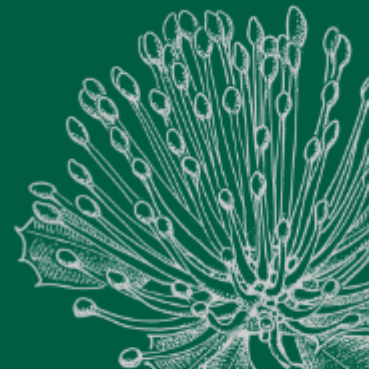
- Manage fire and grazing to retain cover
- Retain dingoes where possible
- Eradicate cats from islands with important seabird colonies
- Targeted cat control at sites with threatened birds
- Better pet cat management

# Cats and the conservation of Australian birds



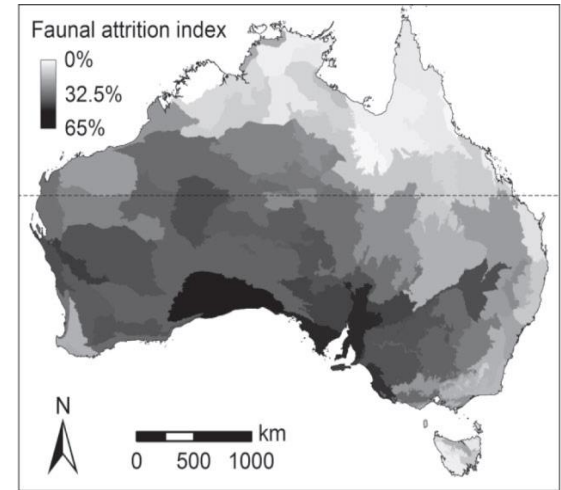
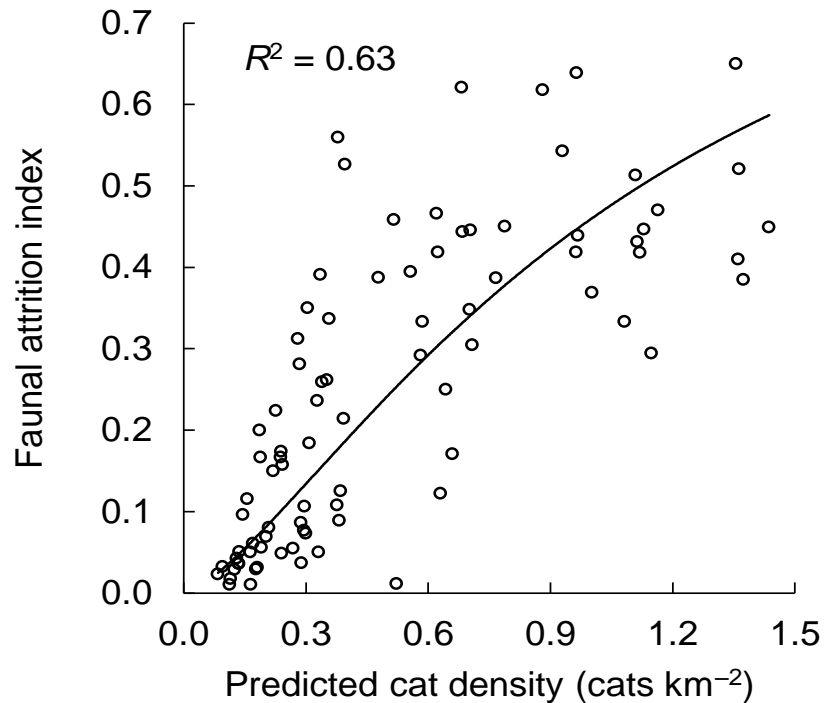
The Threatened Species Recovery Hub is supported through funding from the Australian Government's National Environmental Science Programme.

Sarah Legge, John Woinarski, Brett Murphy, Stephen Garnett,  
Sarah Comer, Chris Dickman, Tim Doherty, Glenn Edwards,  
Alex Nankivell, Russell Palmer, David Paton, Leigh-Ann Woolley



Australia vs other countries	Contiguous USA	Australia
Land area (m km <sup>2</sup> )	8.08	7.69
Pet cat population (million)	84	3.9
No. birds killed per pet cat/yr	8.1	15.6
No. birds killed by all pet cats/yr (million)	684	61
Feral cat population (million)	30-80	2.1
Feral cat density (cats km <sup>-2</sup> )	3.7-9.9	0.27
No. birds killed per feral cat/yr	5-64	129
Total birds killed by feral cats/yr (million)	1,652	316
Total birds killed by feral and pet cats/yr (m.)	2,407	377
(woolly) estimated landbird popn (billion)	10-20	9-13
(woolly) % birds killed by cats/yr	12-24%	3.5%

# An aside: spatial variation in cat density is eerily similar to spatial variation in loss of native mammals



Cat density

