

# Waterbird Theme

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Three species of Australian Ibis:  
Straw-necked Ibis, Australian White Ibis, Glossy Ibis

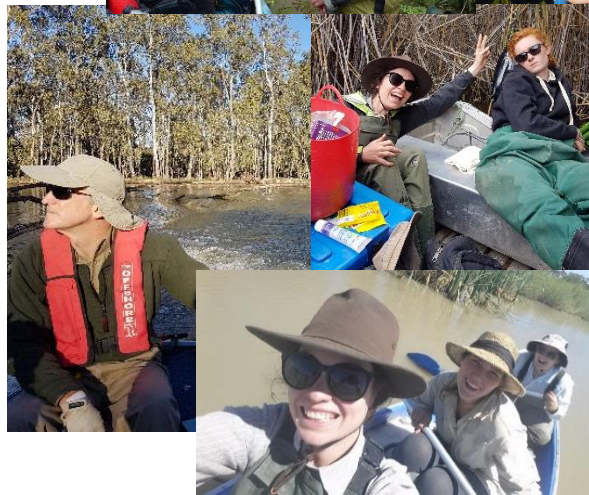


# Acknowledgements

- CSIRO colleagues
- EWKR colleagues, especially Theme Coordinators and MDFRC/CFE management and leadership
- Keith Ward and GBCMA colleagues
- Ali Borrell and Rick Webster
- Tim Hosking and NSW OEH colleagues
- Land and water site owners and managers
- Students, volunteers, and interns
- Everyone who searched for transmitters!
- CEWO staff
- CMA and LLS staff
- NSW, VIC, QLD, SA and ACT govt staff



*Vale  
Rick Webster*



The expected outcomes of the Australian Murray-Darling Basin Environmental Watering Strategy for waterbirds are ‘increased abundance and the maintenance of current species diversity’ (MDBA 2014).

To achieve this, we need to address knowledge gaps and issues including:

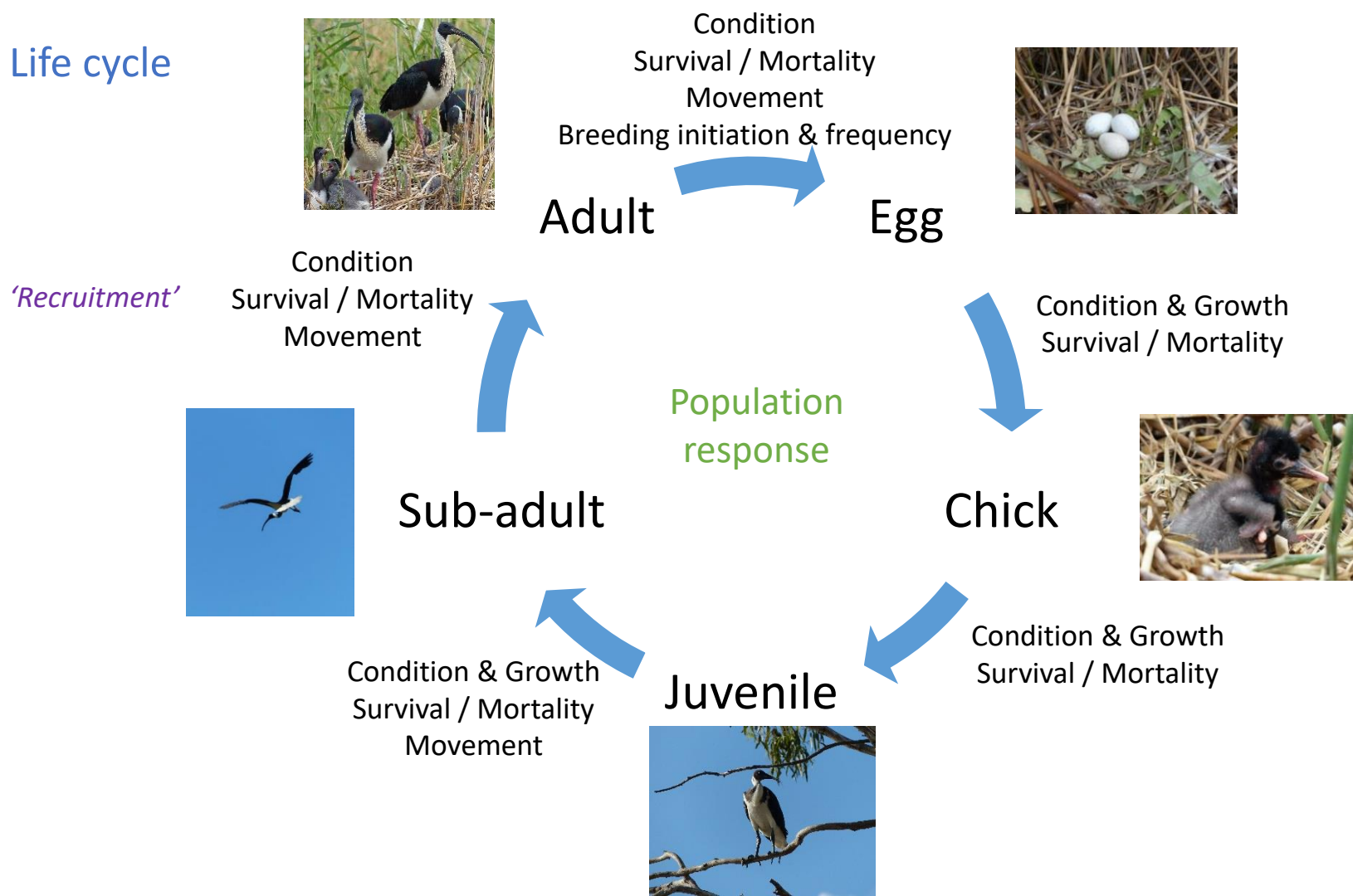
- a) Drivers of and threats to recruitment
- b) Demographic rates
- c) Movements

Doing so will improve our capacity to more effectively target land and water management actions and predict their effects





# Life cycle





# What do managers want to know?

## We asked them...

- Population movements and boundaries
- Important routes, foraging trip distances and other key movement limitations and preferences
- Critical foraging, roosting and stopover sites
- Priority habitat characteristics to maintain
- Recruitment-limiting stressors, threats, pressures



## Colonial-breeding waterbirds: Ibis and spoonbills

### Movements: Detailed solar GPS satellite-tracking

- Three species
- Adults and juveniles
- Movement distances
- Routes and important areas
- Timing and rates
- Habitat characteristics: Foraging, roosting, travelling
- Survival rates

Birds fitted with transmitters



## Nest success: cameras, nesting site surveys and modelling

- Egg and chick survival rates
- Predation
- Nest exposure and habitat characteristics

## Chick food (energy) requirements

- Chick growth
- Chick food (energy) requirements
- Chick diet





# Why colonial-breeding waterbirds?

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- Important targets for environmental flows management and policy
- Response variables more easily measured than for other species
- Locations of major colonies are known
- Breeding thresholds related to flows are basically known
- Estimates of recruitment likely to cover a greater proportion of each population
- Effects of predation and other threats more easily measured



# Nest success: Egg and chick survival and mortality

- Hatching and survival rates varied between seasons and species
- Royal spoonbills had significantly higher hatching and survival rates than the two ibis species
- Straw-necked ibis had the lowest chick survival rates
- Primary mortality drivers: Predation, egg rejection, nest abandonment, failure to hatch

	Royal Spoonbill	Straw-necked Ibis	Australian White Ibis
Mean clutch size	2.5	1.7	2.3
Max clutch size	4	3	6
% Hatch rate	72	59	58
% Chick survival from all eggs laid	50	14	30
% Chick survival from eggs that hatched	70	24	51









CSIRO summer scholarship student: Lauren O'Brien



Colonial-nesting waterbirds can account for a significant proportion of energy flow through wetlands

- Particularly when breeding, when total energy required = Chicks + Adults
- Raising young may double the daily energy requirement of parent birds

➤ *If the energy required to rear chicks can be calculated:*

- *We could develop landscape scale management targets for food production and foraging habitats*
- *Ensuring that food availability requirements are met to support breeding success and population level recruitment*





# Chick energy (food) requirements: Results



- New measurements of ibis and spoonbill chick biometrics for Royal Spoonbill and Australian White Ibis
- The first predictive models of Royal Spoonbill growth
- The first predictive models of Royal Spoonbill and Australian White Ibis chick energy requirements

To raise a single royal spoonbill chick:



139 kJ/day  
Hatchling



**71,290 kJ**



1800 kJ/day  
50 days old

# How much food is that?



71,290 kJ



= 950 x 10-cm fish

OR

= ~35 x



OR 14 kg of 10-cm fish

OR 178 yabbies

So for a breeding event with **1000 nests** producing *three* chicks per nest:

**42 tonnes of fish = 2.3 million 10-cm fish**

OR

**53 tonnes of yabbies = 0.5 million 100-g yabbies**

*Are our current management practices producing this?*

# Waterbird diet: Food (energy) sources consumed



Food items	Royal spoonbill	Straw-necked ibis
Fish	Carp, smelt, goldfish, gambusia, redfin, gudgeons	Yes
Tadpoles	Yes	
Frogs		Yes
Crustaceans	Shrimp, amphipods, isopods, crayfish, yabbies, crabs	Crayfish, crabs, shrimp
Molluscs	Shellfish, snails	Snails, bivalves
Aquatic invertebrates	Dragonfly nymphs, bugs, beetles	Yes
Terrestrial invertebrates	Yes	Spiders, crickets, grasshoppers, locusts, beetles, caterpillars, centipedes, earthworms
Spiders		Yes
Snakes/lizards		Yes
Mammals		House mice, rats
Plants	Medicago seeds, nardoo	

Barker and Vestjens (1989a); Marchant and Higgins (1990).

## Waterbird Theme - Food Web Theme collaboration

### Bringing together

1. How much energy is needed
2. What are various foods worth (energy)?
3. Are some foods better quality than others?
4. Which foods are better assimilated than others (vs. ingested)
5. Food availability - how much is out there?

How many birds and species do we want?

How much food do we need to ensure this?

How can we better manage water to provide this?



Edwin Long:  
Alethe, attendant  
of sacred ibis in  
temple of Isis, 1888



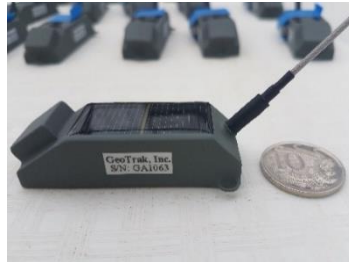
Juvenile ibis regurgitate: frogs, spiders, beetles





## Transmitter features

- **High frequency** location fixes – *hourly* 7am-7pm + midnight fix
- **High accuracy** GPS location fixes – 10's of *metres*, usually <10 m
- **Long duration** *solar-powered* tracking – e.g. 2 years
- **Full coverage** across Australia – ARGOS satellite system
- **No recapture** or base station required – satellite upload and download
- **Lightweight**: Multiple sizes for different size birds



*Releasing an ibis after fitting a transmitter*







### Tracking movements

2016-2017: 20 transmitters

2017-2018: 44 transmitters

Straw-necked ibis:	42
Royal spoonbill:	15
Australian white ibis:	7

### Capture sites

#### 2016-2017 (Wet)

Macquarie Marshes  
Barmah-Millewa Forest

#### 2017-2018 (Dry)

Kow Swamp  
Kerang Lakes  
Barmah-Millewa Forest

# Duration of tracking: Number of days per bird



- Even with short-duration tracking, detailed data are available (hourly fixes)
- Particularly post-nesting period
- Eight birds still active

	Straw-necked ibis	Royal spoonbill	Australian white ibis
Maximum	588	256	466
Mean	198	69	263
SD	175	61	211



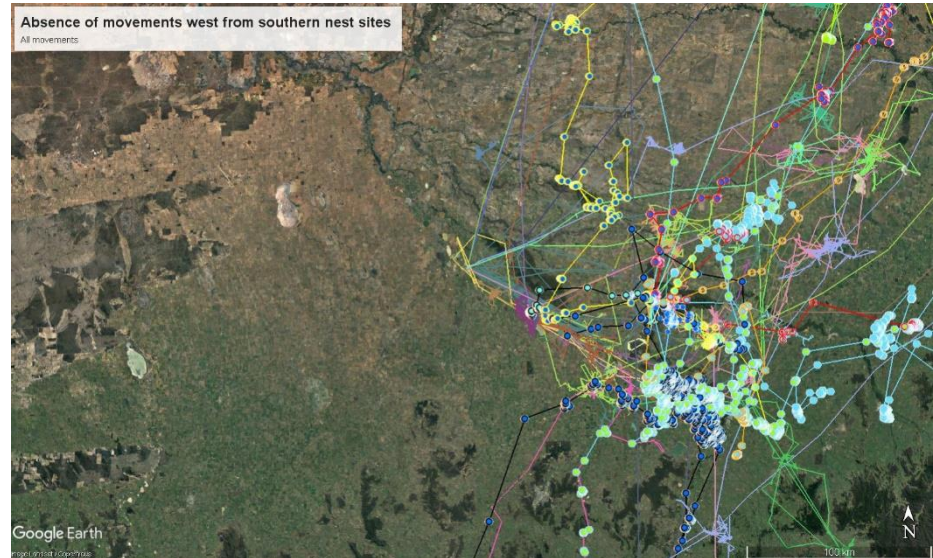
So far:

~10,800 days  
of tracking  
data

~150,000  
Location  
fixes



- Temporally clustered departures
- Royal spoonbills **months later** than straw-necked ibis and white ibis
  - Spoonbills forage IN and around the nesting site
  - Implications for duration of environmental flows
- Murray River straw-necked ibis adults and juveniles mostly north-east, east
- Macquarie Marshes straw-necked ibis adults flew south (only 5 birds)



# Highlights and trends

## Common long-distance routes for different individuals and species

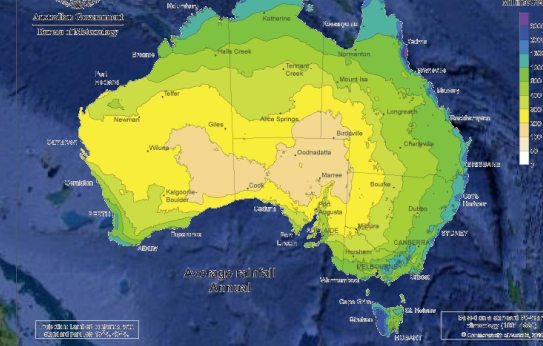
The same NE-SW route has been used in **both years** by straw-necked ibis juveniles and adults

Route also used by juvenile and adult royal spoonbills

Route used in both directions, from different sites

Avoiding dry, high elevation, or forested areas

Corresponding with climatic / bioregional zones



Temperate to Sub-tropical

No 'dry season'

High soil moisture

Low elevation

Low-mod rain variability

Mean annual rainfall

~600-700mm

(400-1000mm)

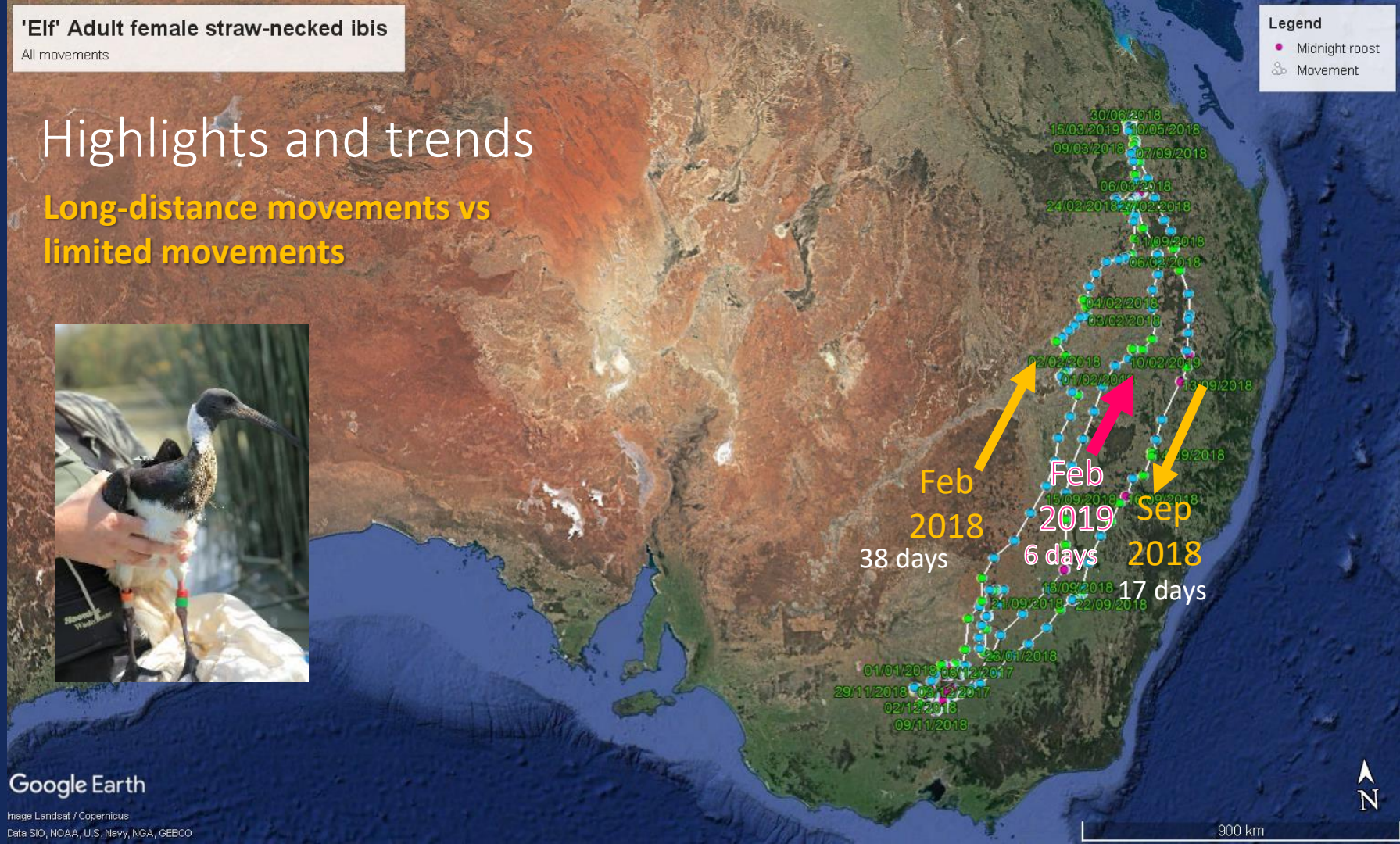
Mostly west of Great  
Dividing Range





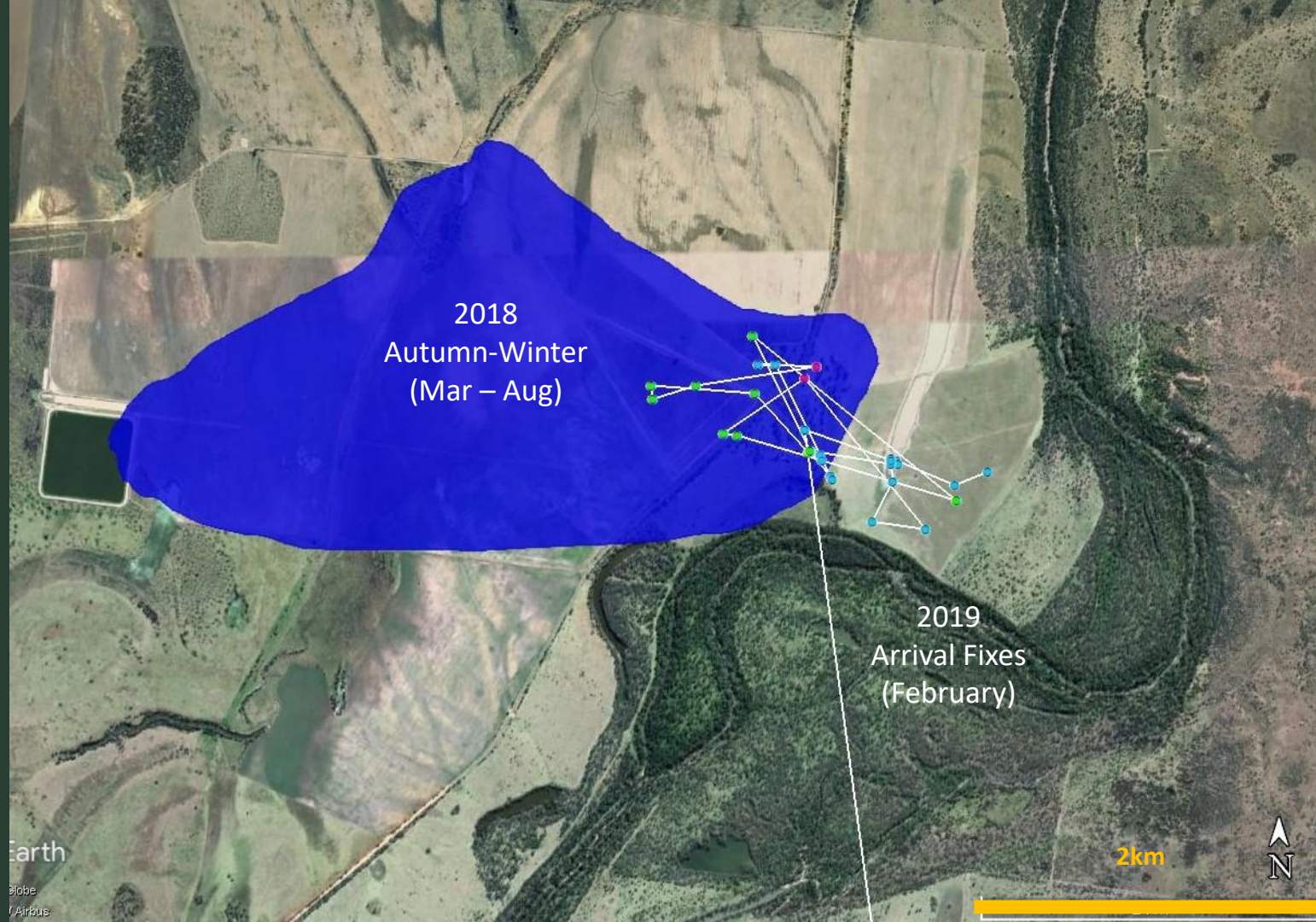
## All movements

## Long-distance movements vs limited movements





## Site fidelity



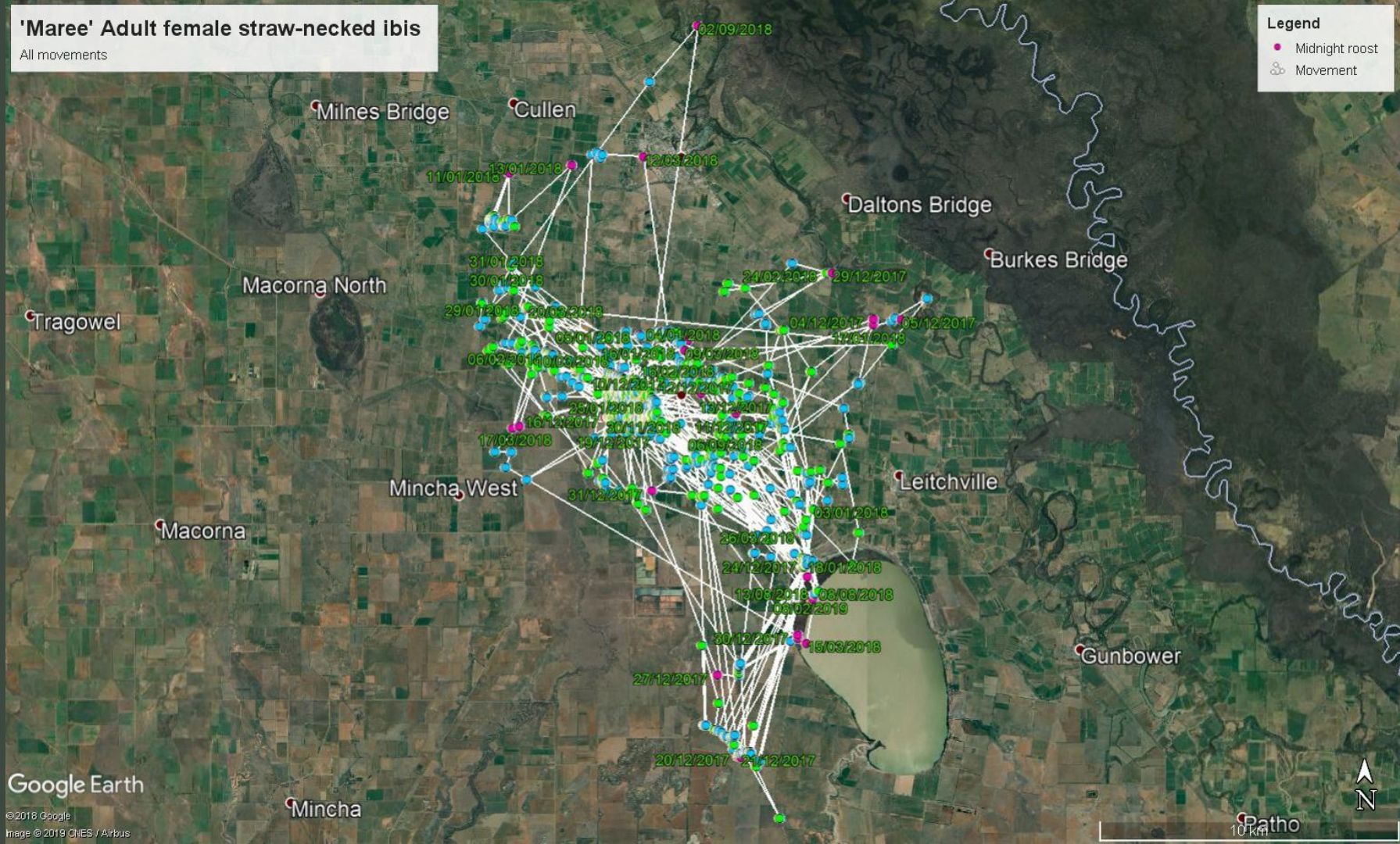


# 'Maree' Adult female straw-necked ibis

All movements

## Legend

- Midnight roost
- Movement



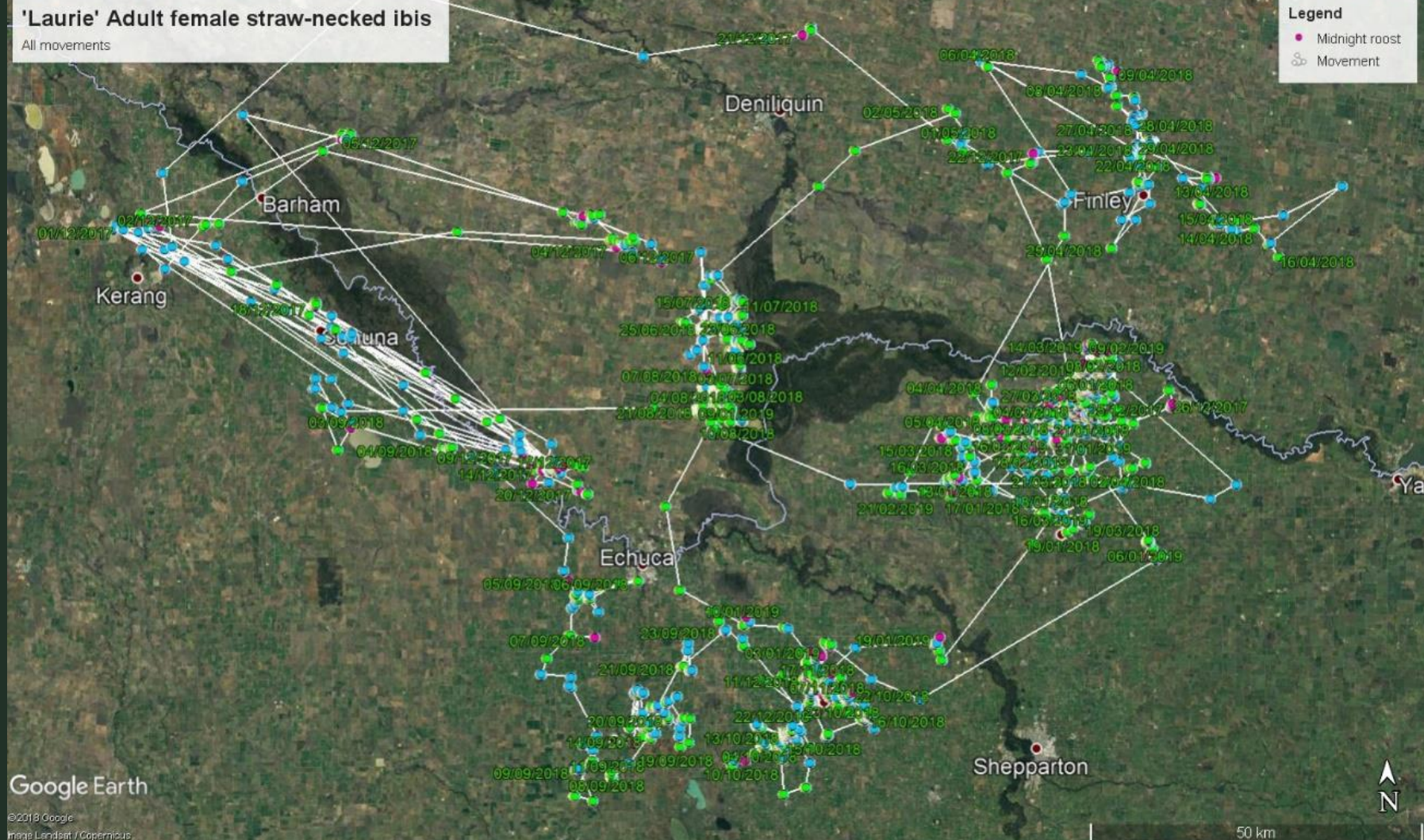


# 'Laurie' Adult female straw-necked ibis

All movements

## Legend

- Midnight roost
- Movement





# Long-distance vs limited movements



## Individual variation in behaviour within species

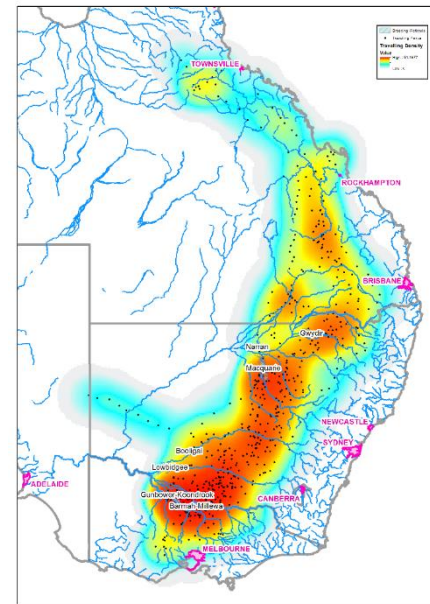
- 'Partial migration' population strategy?
- Resident vs nomadic vs migratory

## All tracked birds 'settled down' in autumn-winter

- Highly localised over-wintering areas (within ~5km)
- Site characteristics vary between individuals

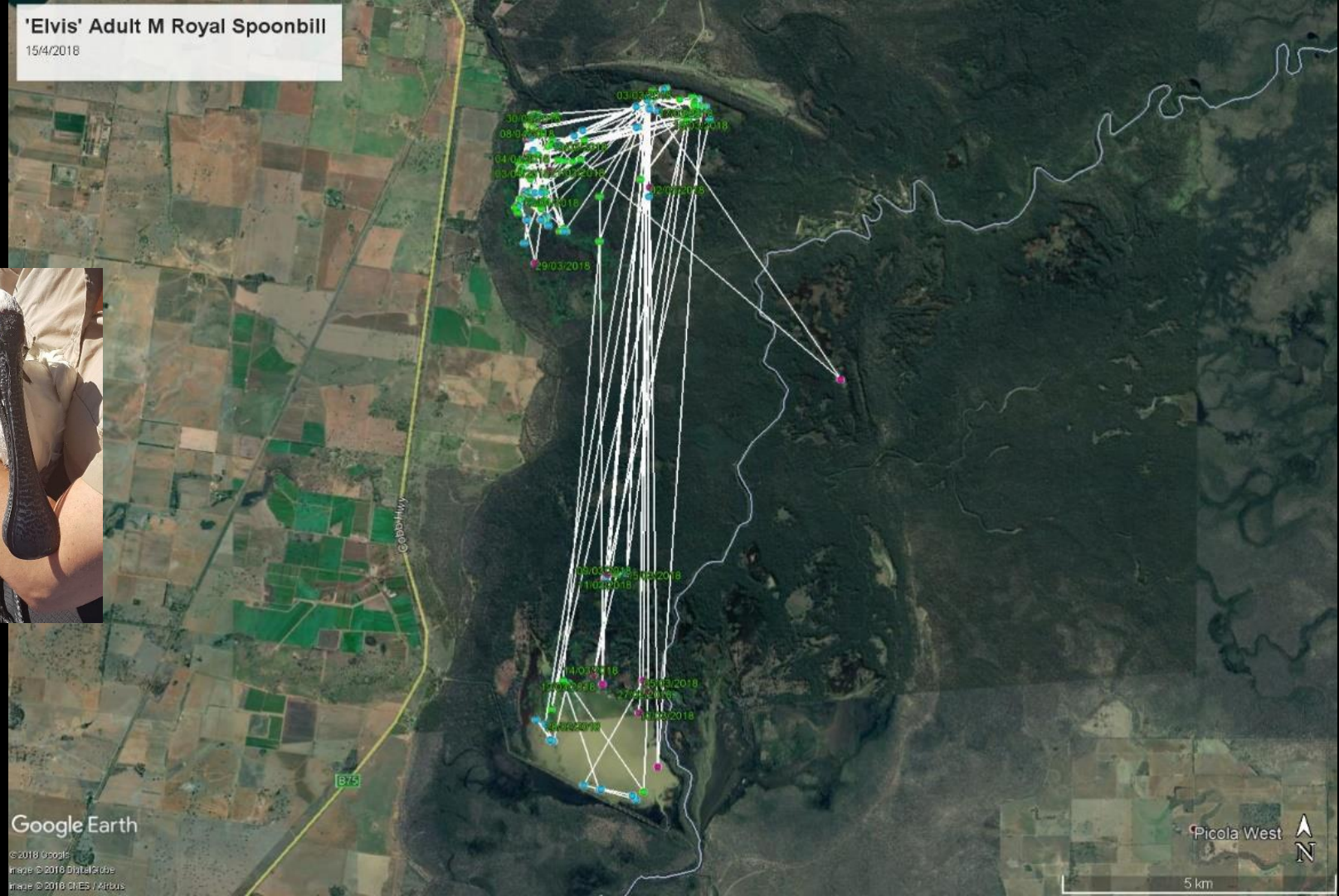
## Species variation

- Australian white ibis far more 'resident'
- Royal spoonbill adult flew directly from nest site to QLD



25% of tracked birds used common route  
15% of tracked birds flew to Queensland

'Elvis' Adult M Royal Spoonbill  
15/4/2018



Google Earth

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Image © 2018 DigitalGlobe  
Image © 2018 CNES / Airbus



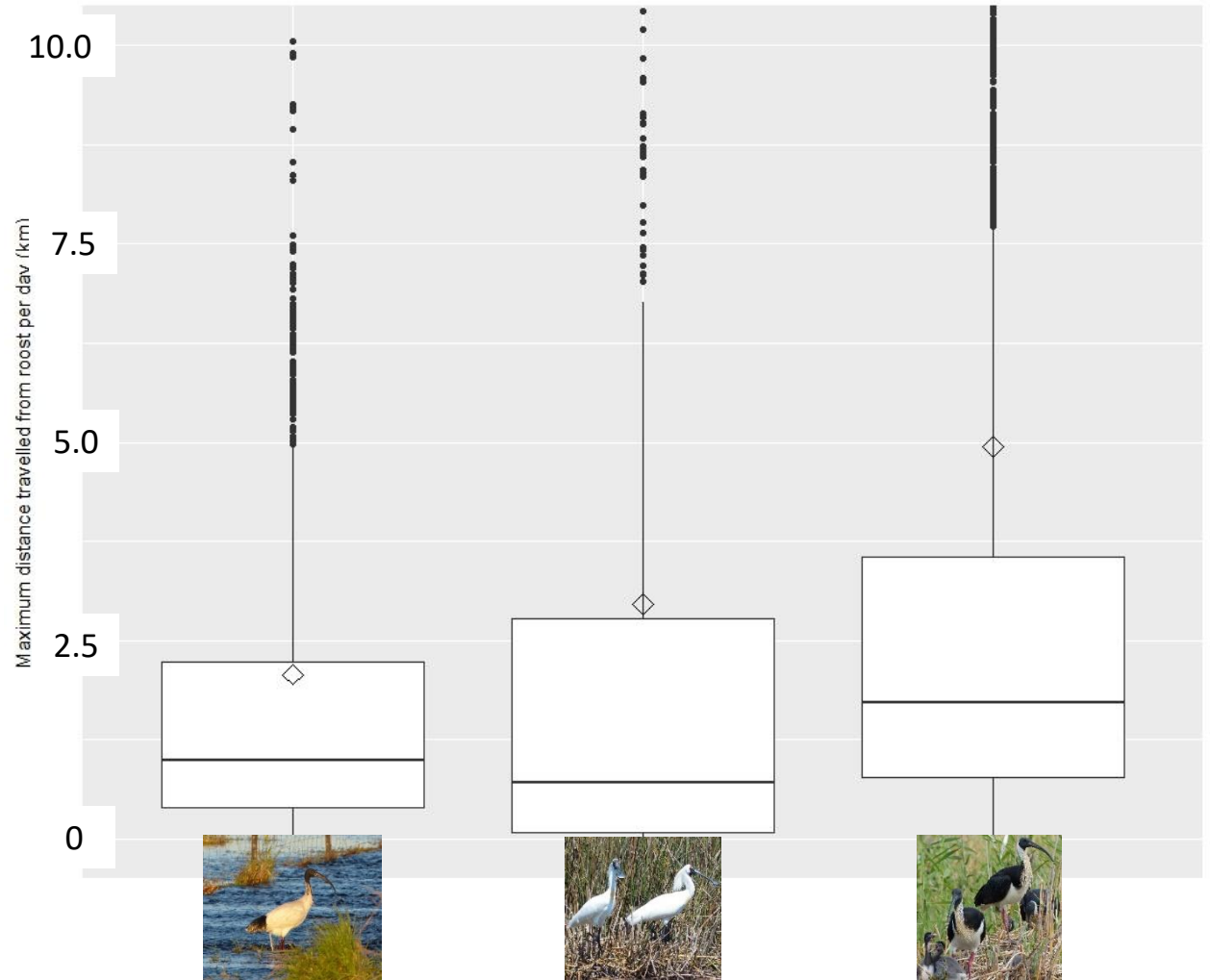
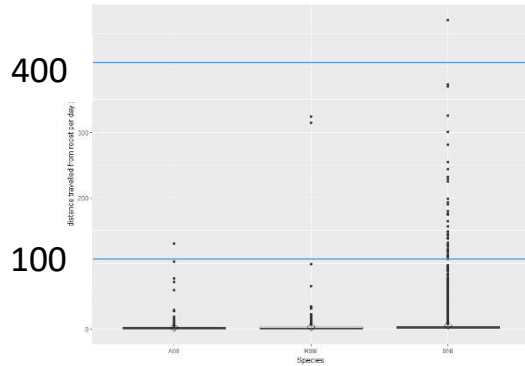
# 'Elvis' Adult Male Royal Spoonbill





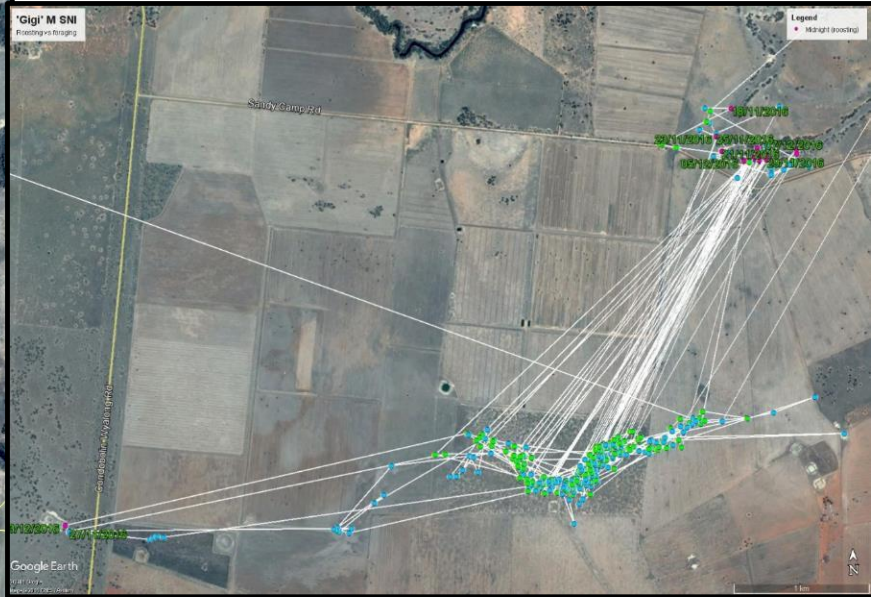
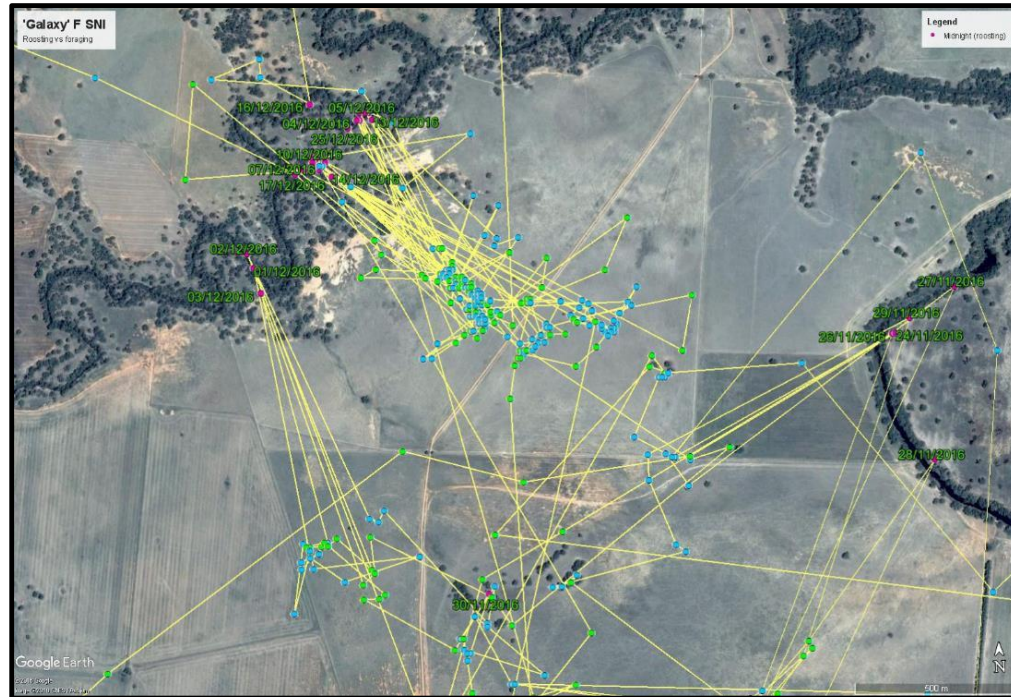
# Maximum distance travelled from midnight fix per day (km)

How far do birds travel away from their roost to feed?

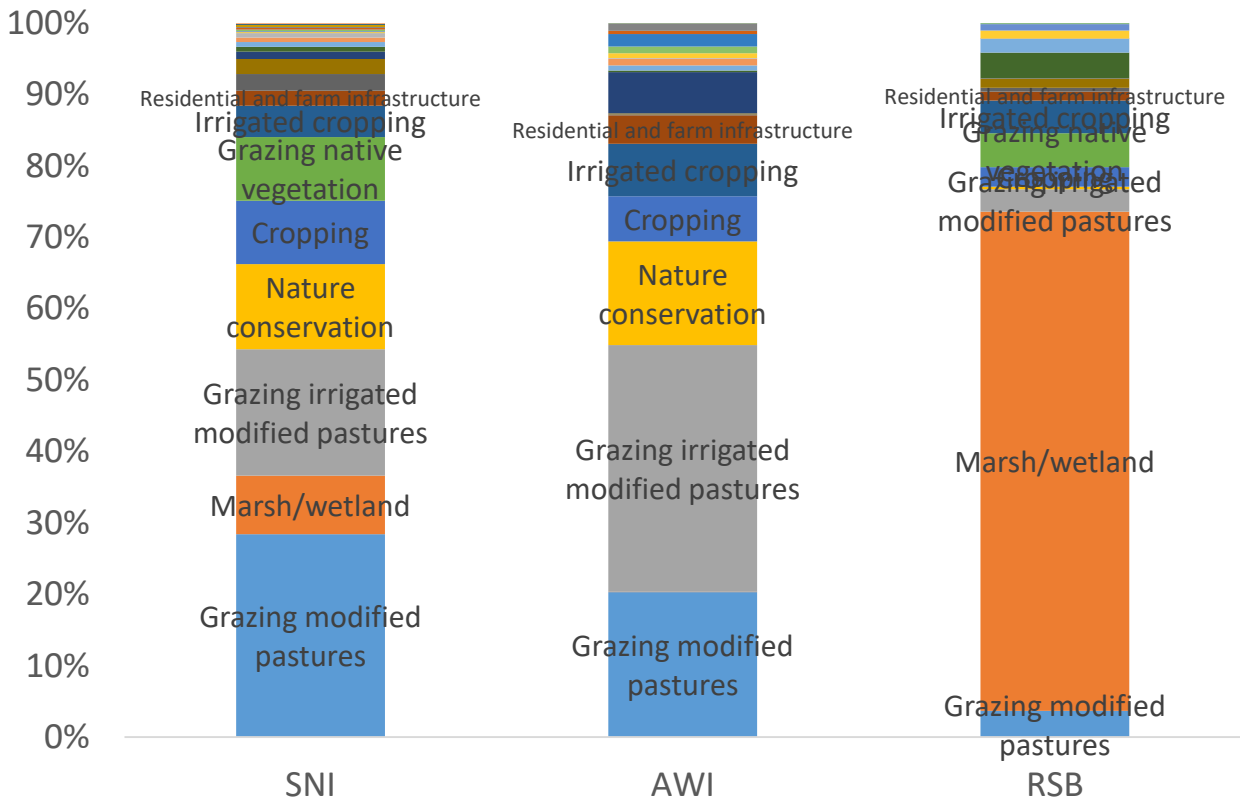


# 'Paired' habitats for roosting and foraging

- Foraging habitats have adjacent remnant vegetation with trees for roosting – within a couple of km
- Preference for tall roosting trees next to or overhanging water



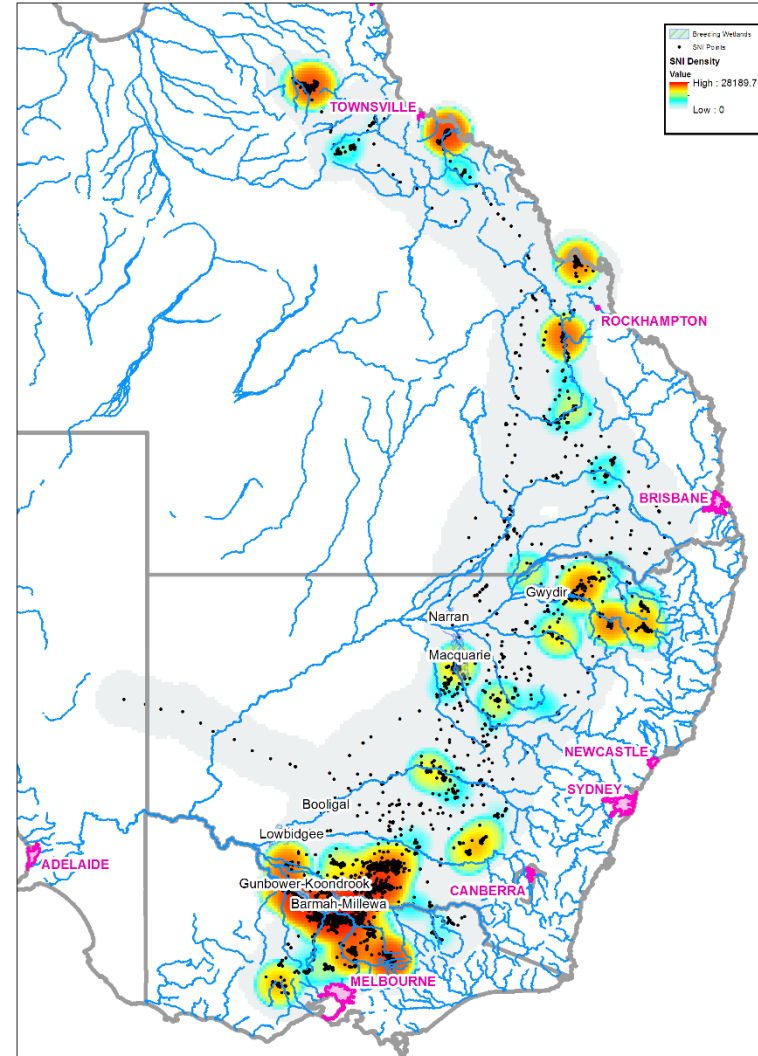
# Landuse by species

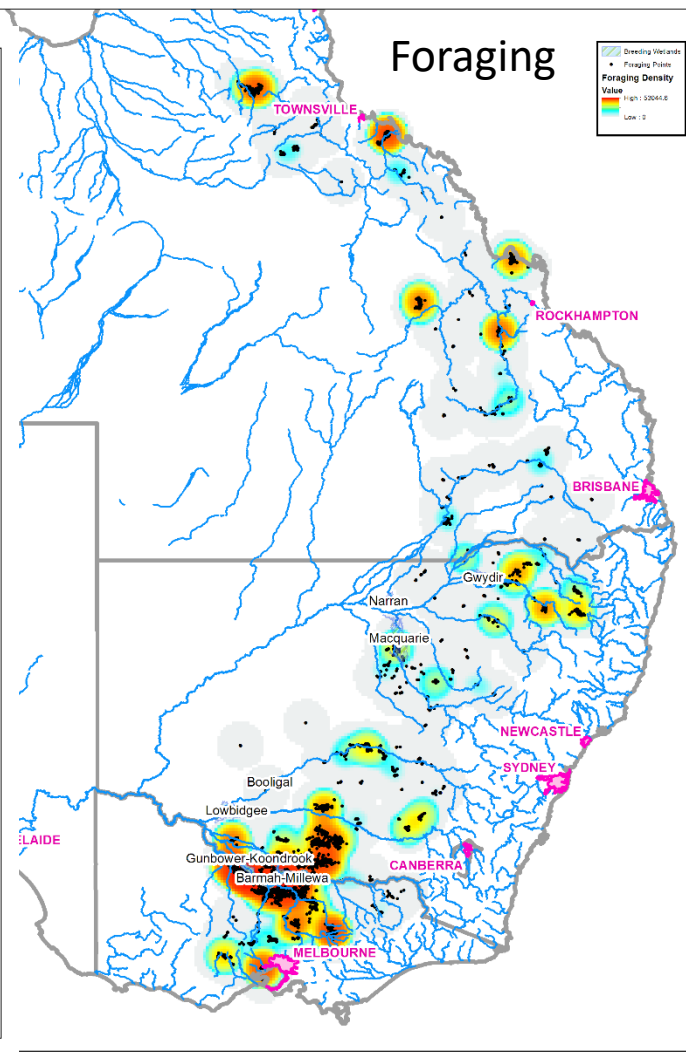
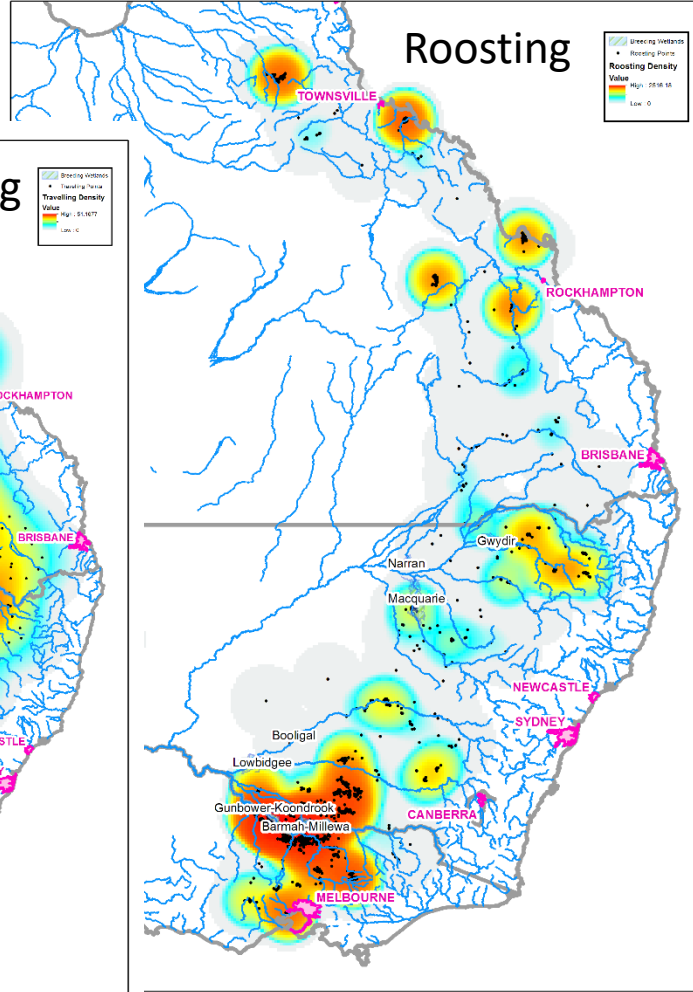
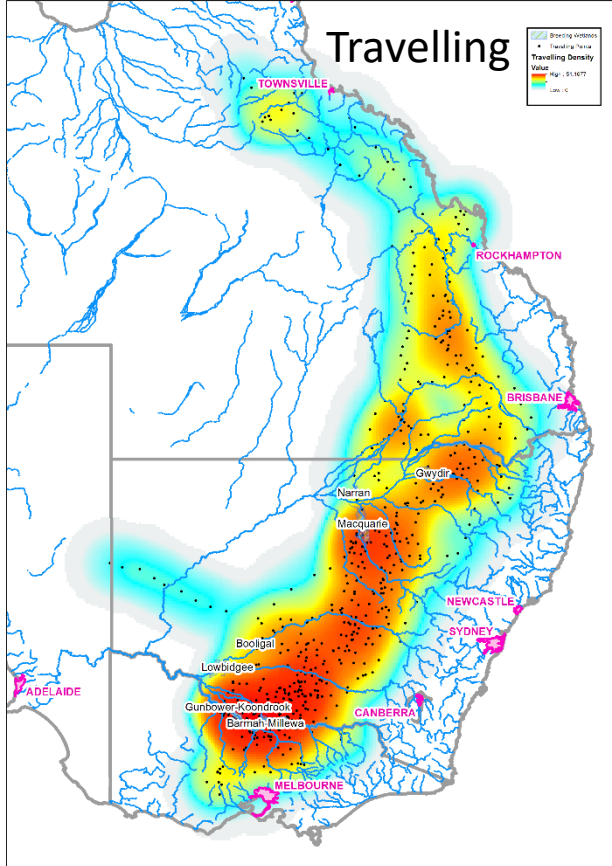




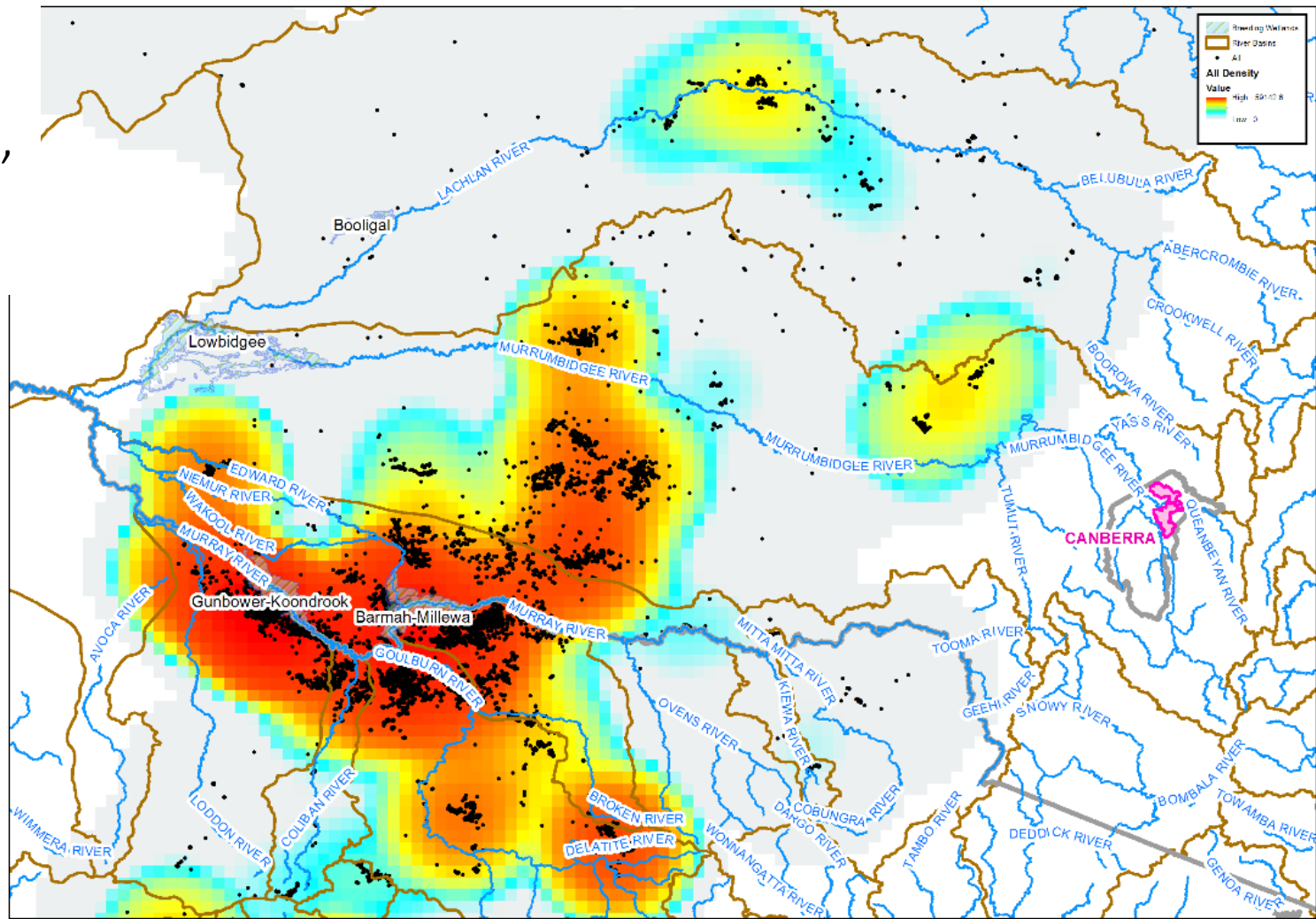
# Key foraging and stopover areas

- Re-use of some sites by different birds at different times
  - the mid-Lachlan River near Condobolin, NSW 2016-2017 (Wet Year)
  - dairy farms in northern VIC, 2017-2018 (Dry Year)
- Species, individuals, total time tracked, season, year etc. important
- Biased by capture locations – may not reflect whole of population





# Murray, Murrumbidgee, Lachlan





# High mortality rates

## Multiple causes of mortality:

- Heat exhaustion / cold / exposure (weather extremes) (28%)
- Predation (e.g. raptors, foxes) (26%)
- Shooting (6%)
- Disease (e.g. botulism, widespread in 2016–17) (4%)
- Vehicle impact (4%)
- Unknown (26%)
  - Other diseases
  - Poisoning / toxins
  - Starvation / malnutrition
  - Parasites
  - Entanglement in nesting material, fencing, powerlines, etc.

Juveniles are more susceptible than adults to these pressures

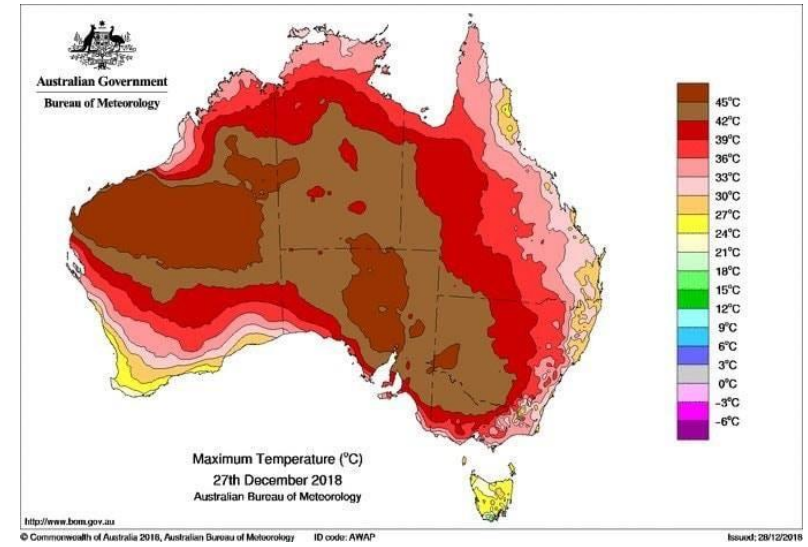


# Extreme weather events

## Associations between weather extremes and mortality

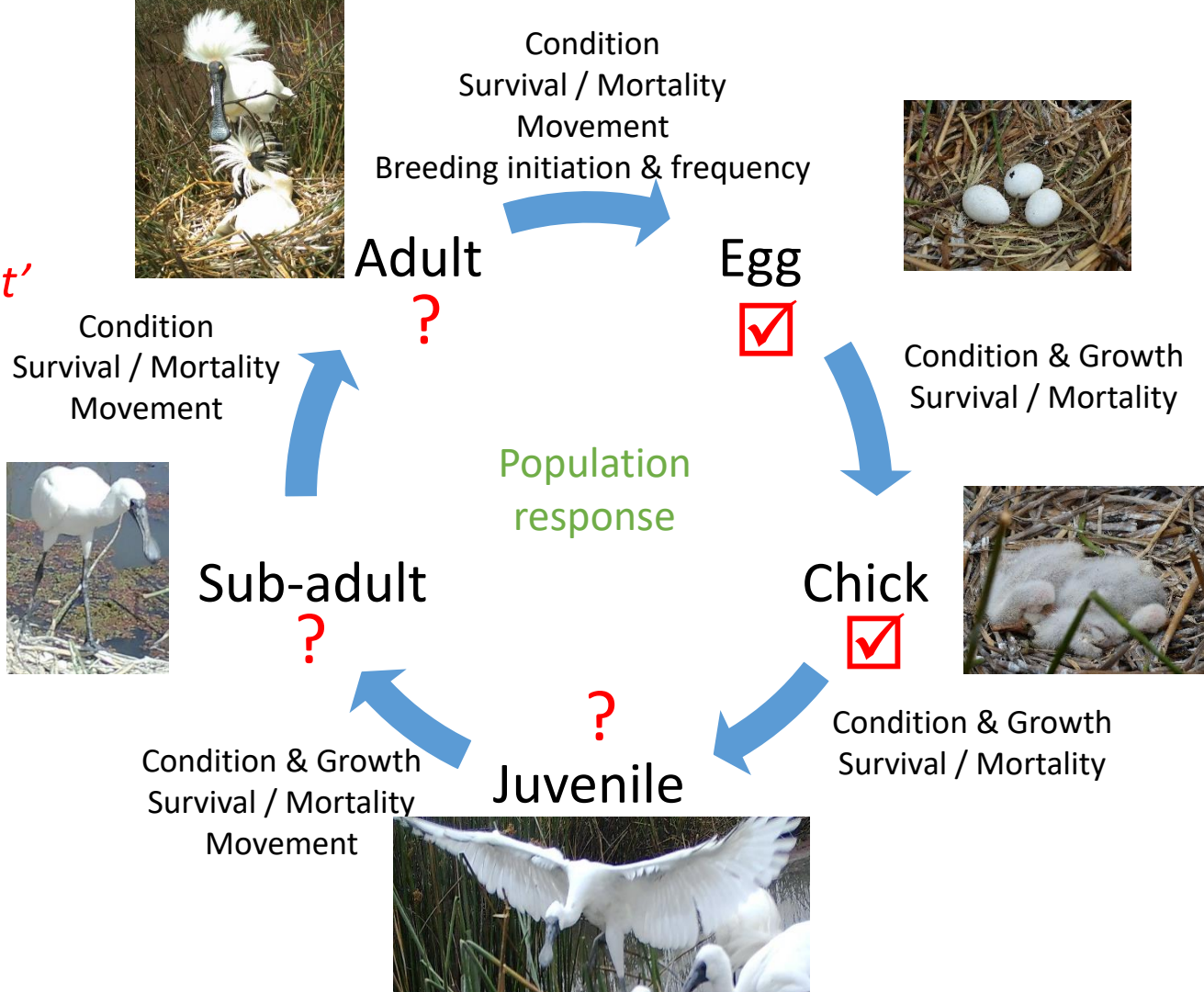
➤ Especially shift from heat to cold within two days

- Thermoregulation and shock
- Immune system depression
- Increased susceptibility to diseases, toxins and parasites
- Juvenile body condition decreases and mortality risk increases after leaving the nest



# Life cycles

*'Recruitment'*





## New sub-populations, species and sites

- Species dependent on water to feed as well as breed
- Additional sites in the MDB – e.g. Murrumbidgee, Narran
- Species known or suspected to be in decline or at risk

## Complementary techniques

- Genetics; Environomics; E-dna; Isotopic analyses; Pathology; Citizen science

## Biological / ecological knowledge gaps – so many!

- Food availability (limiting factor?) - spatial and temporal variability
- Population dynamics and life history, including mortality rates and drivers
- Sub-population boundaries/connectivity/existence, ranges
- Philopatry and natal philopatry, postfledging care of juveniles
- Movement cues and modifiers – e.g. flooding characteristics, thermals, weather
- Variation among individuals, sexes, and age categories
- Timing of departures and arrivals and relationships with other factors
- Physical and behavioural changes as birds age (e.g. how can we 'age' them more accurately?)



## Basin scale thinking!

North-south population connectivity in the MDB - and birds can move very quickly

- Need basin-scale water management and coordination
- Account for population movement strategies – migration, nomadism and residency
- Account for among-species differences

There seems to be a common route / area

- Within which MDB water and site management should be embedded
- Individual sites differ in importance among years and species – why?



## Foraging sites

Foraging habitat availability needs management both during AND between breeding events

- Need watered foraging sites within 1-3 km of appropriate roosting or nesting habitat
- Increase number / area of foraging sites within 10 km of nest site after breeding - into autumn and winter
- Possibly stagger inundation of foraging sites to maximise food productivity over months

Management of over-wintering sites and foraging habitats may be important for juvenile survival

- Small habitat areas for each individual bird
- Overwintering occurs in north and south of MDB
- There is site fidelity for some individuals

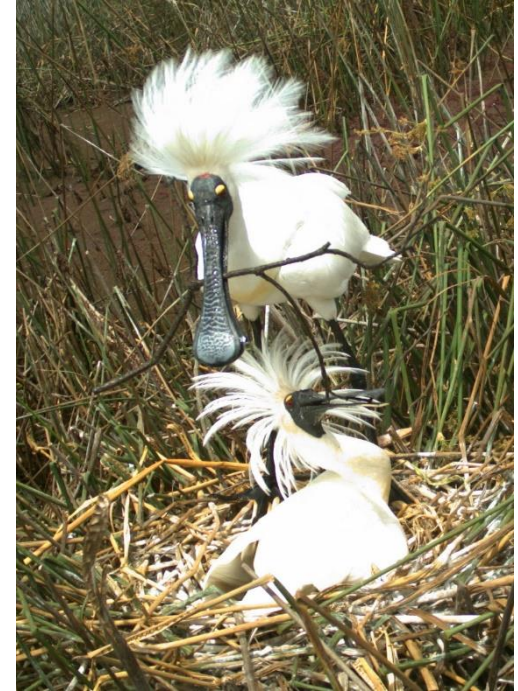




## Nesting sites

For spoonbills, extend nest site flood duration during and after nesting (e.g. to April in the south)

- Beyond just the ‘fledging’ time threshold - to ‘juvenile survival’
- Species feeding in surface waters require different foraging-habitat provision and management to species with mixed terrestrial and aquatic diets
- Large amounts of food are needed to raise chicks – but how much food is available?



## Outputs and communications

- Website: <https://research.csiro.au/ewkrwaterbirds/>
- Social media pages – Facebook, Twitter
- Regular email updates to subscription list
- Field guide: *'Waterbird chick development: A visual guide to selected Australian species'* (published)
- Booklet: *'Water management for waterbirds in Australia: Lessons learned'* (in development)
- Videos on ABC Open and websites
- Magazine and external website articles
- General public presentations
- Stakeholder presentations
- Scientific presentations
- Radio interviews
- Newspaper interviews
- Scientific journal manuscripts



@AusWaterbirds



Waterbirds Australia



# Thankyou

Questions?

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<http://www.environment.gov.au/water/cewo/monitoring/ewkr>

