

**Stefanie E. LaZerte  
& Elizabeth A. Gow**



# cavityuse

*An R Package for Detecting Cavity Use From Geolocator Data*

<http://github.com/steffilazerte/cavityuse/>

ISBE 2018

@steffilazerte



steffilazerte



steffilazerte.ca

sel@steffilazerte.ca

# Cavities, caves and burrows

@steffilazerte

## Provide

- Shelter
- Nests
- Roosts

## Patterns of use indicate

- Breeding behaviour
- Parental care
- Roosting patterns
- Behavioural rhythms



Visitor7 via Wikimedia Commons

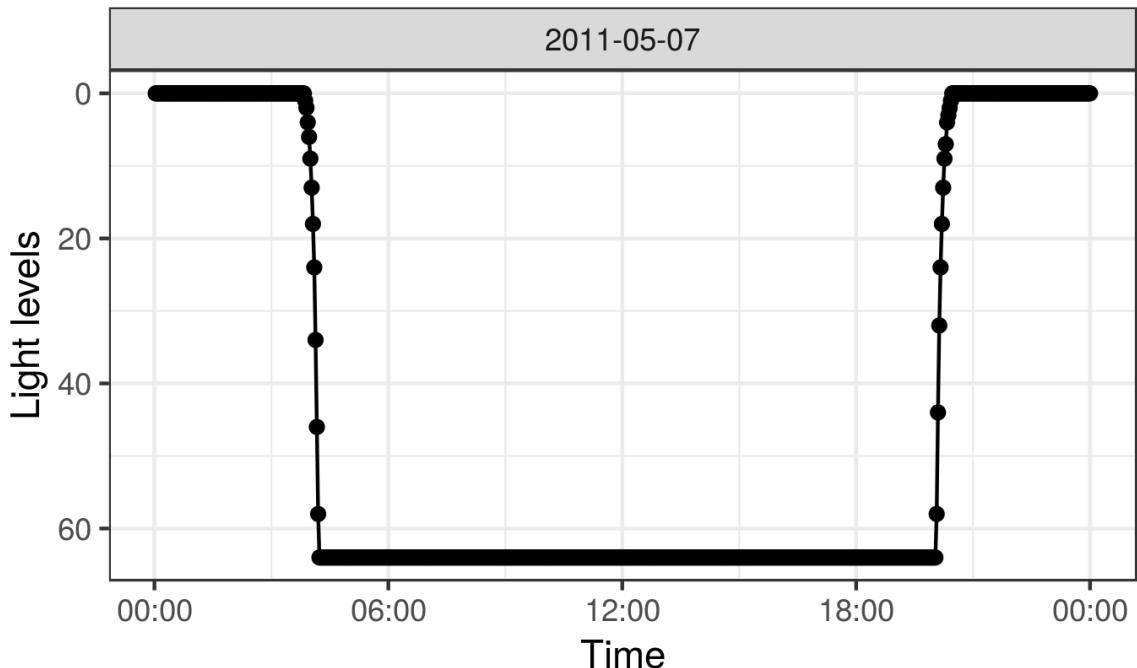
e.g., Roosting Vaux's swifts

# Geolocators

@steffilazerte

## To study migration

- Record light levels
- Time of noon = Longitude
- Day length = Latitude



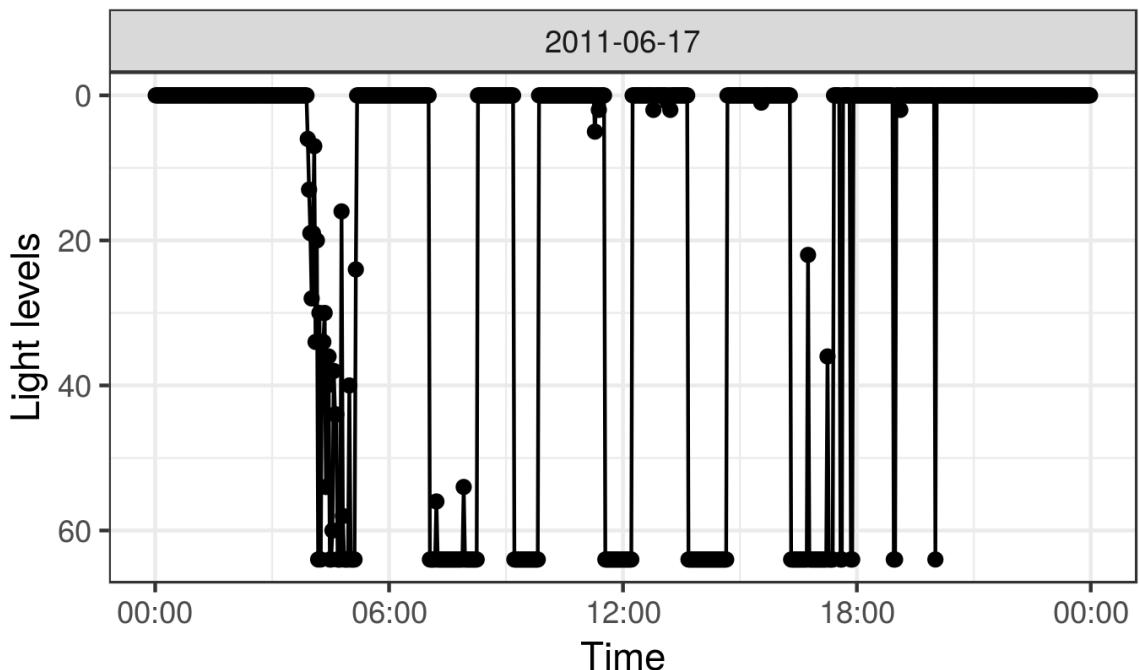
Placing geolocator on white-throated sparrow

# Geolocators

@steffilazerte

## To study cavity use

- Look for abrupt light changes
- Periods of dark during the day



Placing geolocator on white-throated sparrow

# Geolocators

@steffilazerte

## Benefits

- Inexpensive
- Independent of cavity location
- Individual data
- Long observation periods



Scott Ramsay

Placing geolocator on white-throated sparrow

# Geolocators

@steffilazerte

## Used to

- Assess activity in rodents
  - in/out of nest
  - above/below ground



Gilles Gonthier via Wikimedia Commons

e.g., American red squirrels  
Cory et al. 2014

# Geolocators

@steffilazerte

## Used to

- Assess activity in rodents
  - in/out of nest
  - above/below ground
- Assess cavity use in northern flickers
  - in/out of cavity



Dominic Sherony via Wikimedia Commons

e.g., Northern flickers  
Gow et al. 2015

# Geolocators

@steffilazerte

## Used to

- Assess activity in rodents
  - in/out of nest
  - above/below ground
- Assess cavity use in northern flickers
  - in/out of cavity
- Assess incubation in shorebirds
  - incubating/non-incubating



U. S. Fish and Wildlife Service  
via Wikimedia Commons

e.g., Red knots  
Burger et al. 2012

# Geolocators

@steffilazerte

## Used to

- Assess activity in rodents
  - in/out of nest
  - above/below ground
- Assess cavity use in northern flickers
  - in/out of cavity
- Assess incubation in shorebirds
  - incubating/non-incubating

**But data processing!**



U. S. Fish and Wildlife Service  
via Wikimedia Commons

e.g., Red knots  
Burger et al. 2012

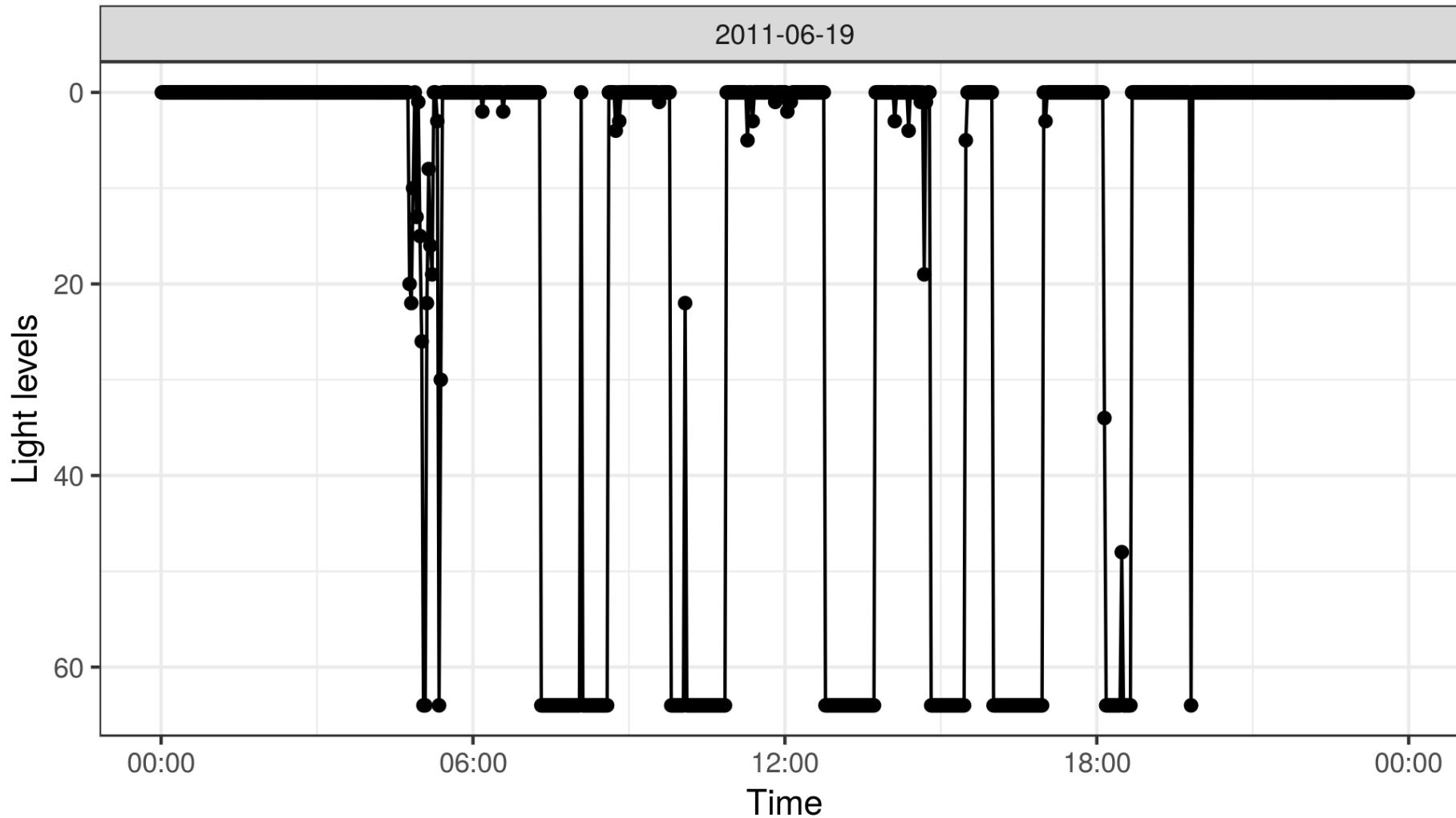
# **cavityuse**: An R package

Leverage the power of



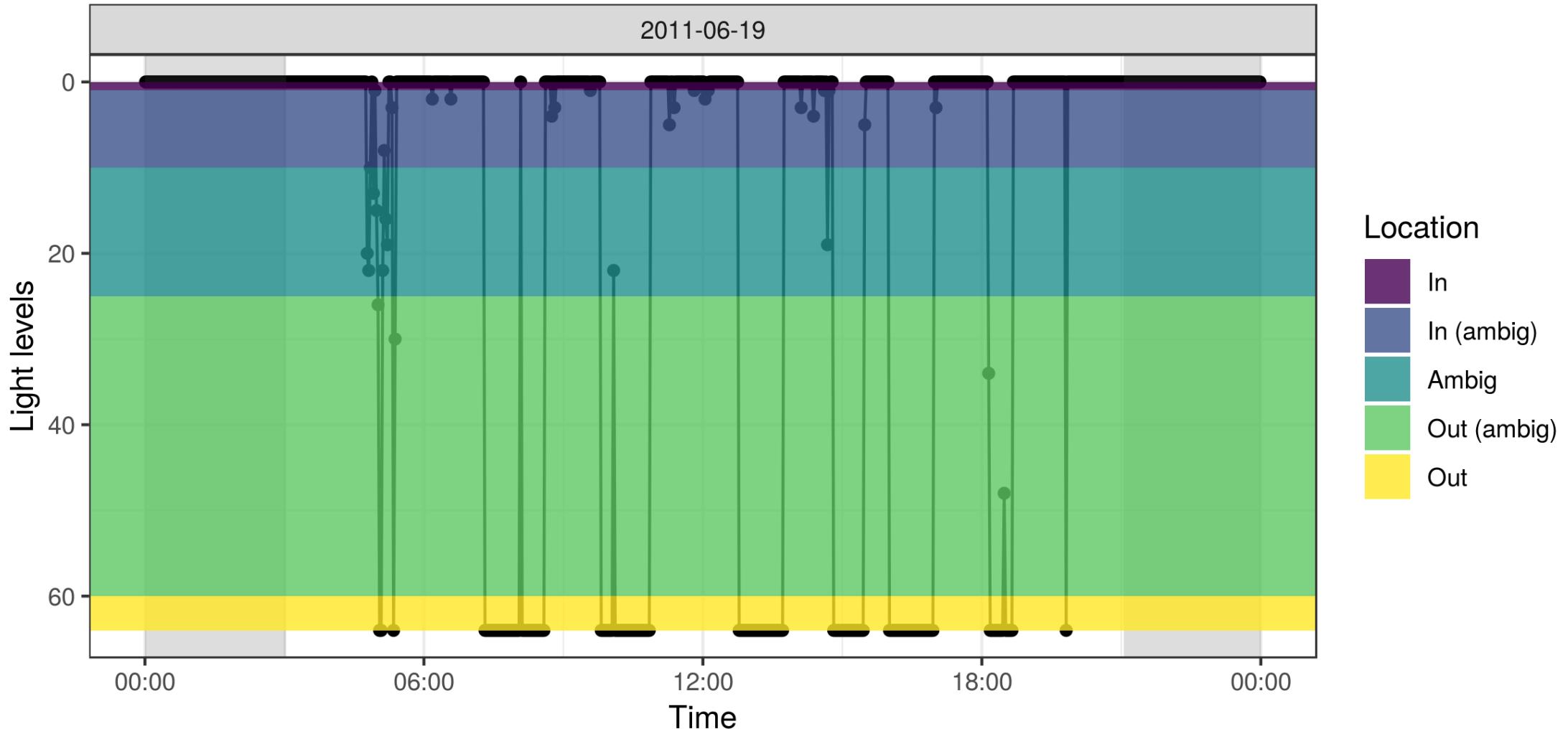
# General Principles

@steffilazerte



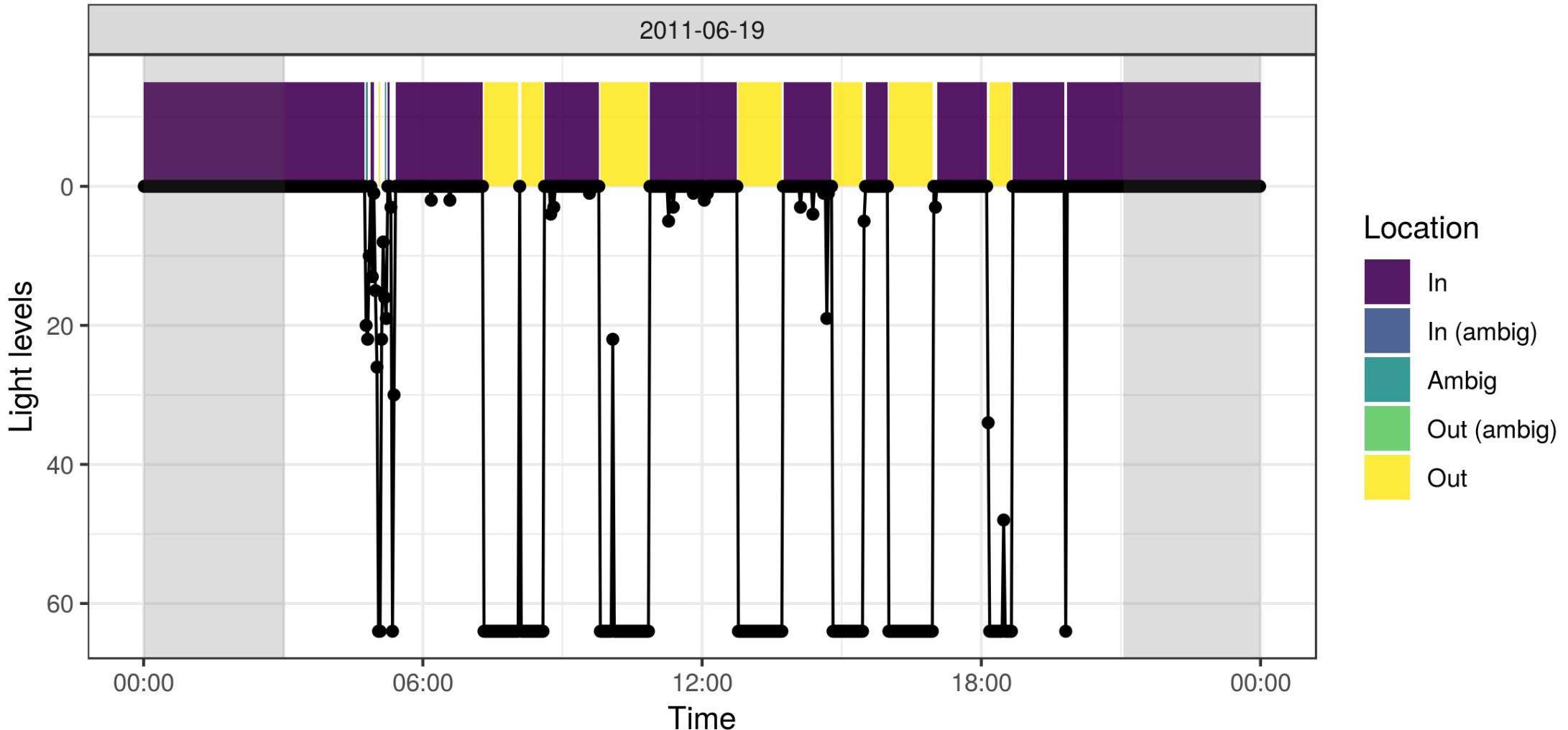
# General Principles

@steffilazerte



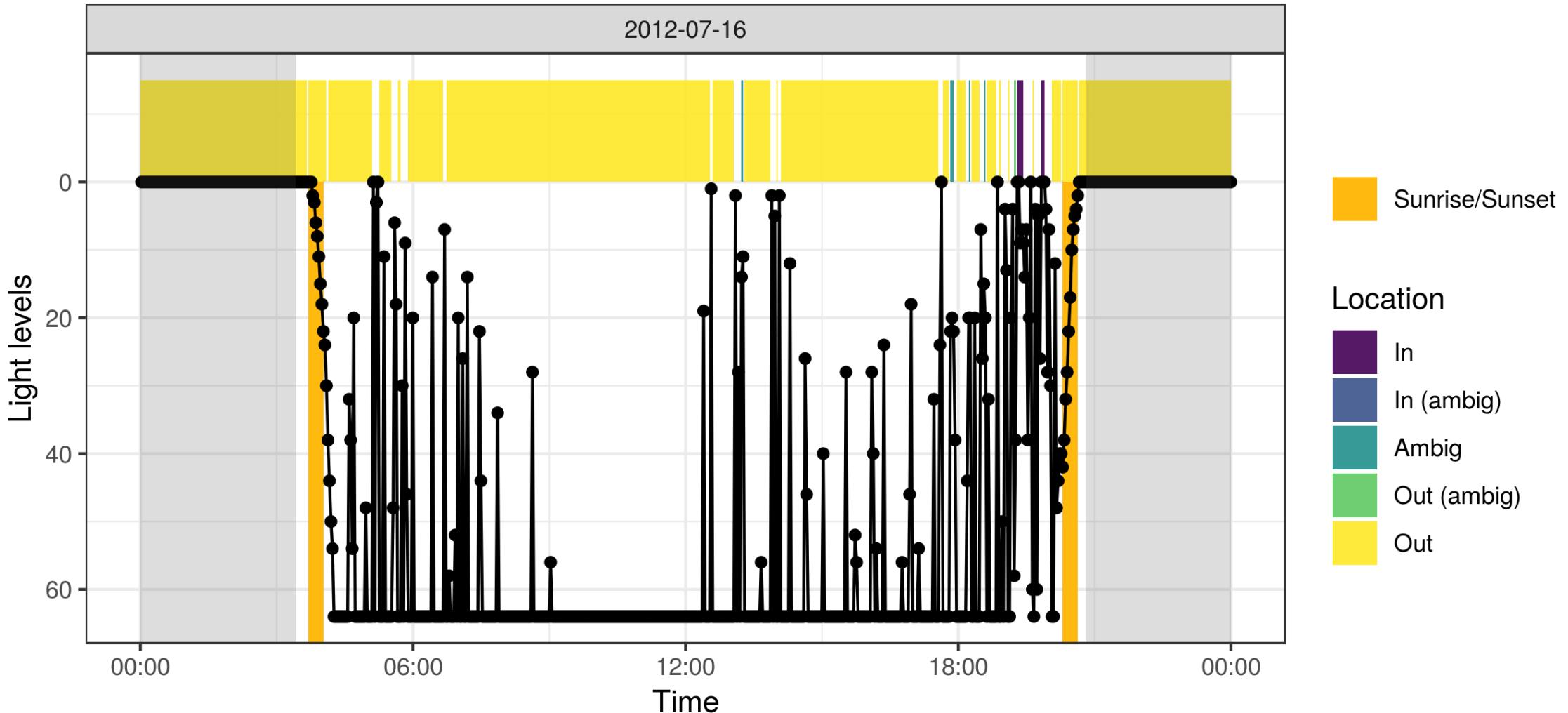
# General Principles

@steffilazerte



# General Principles

@steffilazerte



# Testing cavityuse

@steffilazerte



Northern flickers (*Colaptes auratus*)

## Cavity nesters

Gow, Weibe & Fox; 2015 Ibis



White-throated sparrows (*Zonotrichia albicollis*)

## Ground nesters

Otter, Mckenna, LaZerte & Ramsay; 2017 AOS/SCO Conf.

# Testing cavityuse

@steffilazerte

## Day

- Easier
- Light varies
- Look for light/dark patterns



## Night

- Harder
- All dark
- Look for sunrise/sunset patterns

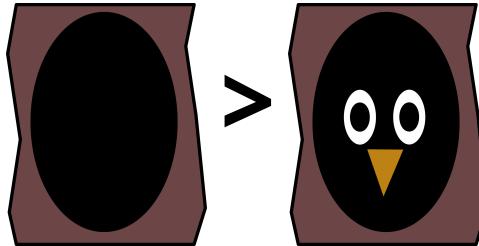


# Daytime: Hypotheses

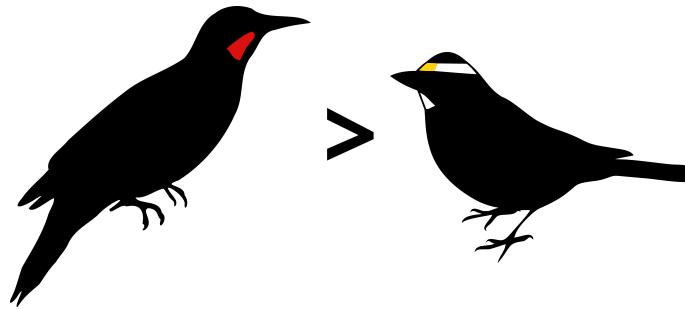
@steffilazerte

## a) Overall cavity use:

Birds spend more time outside than inside cavities



Flickers use cavities more than Sparrows

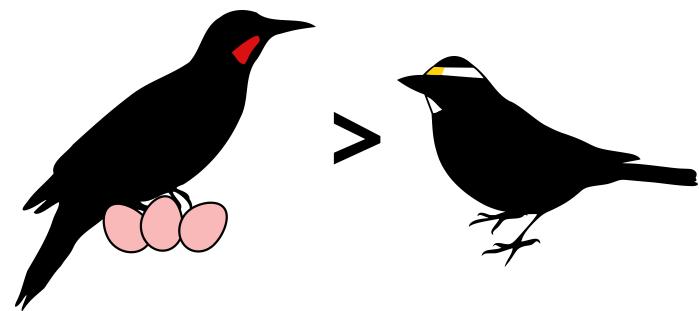
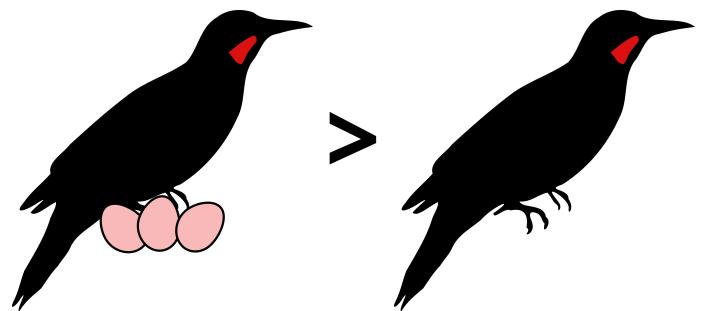


# Daytime: Hypotheses

@steffilazerte

## b) Incubation cavity use:

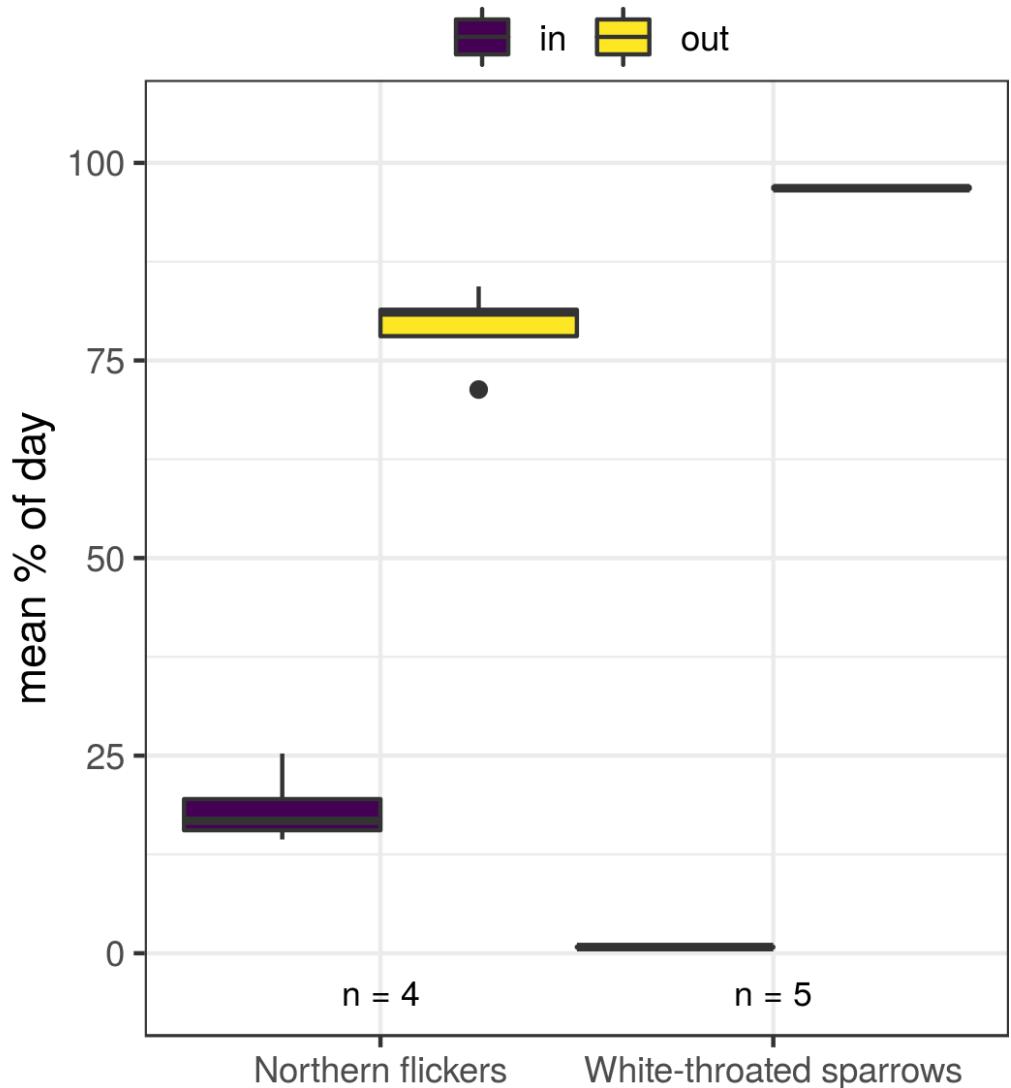
Incubating flickers use cavities more than Non-incubating (Other) flickers & Sparrows



# Daytime: Results

@steffilazerte

## a) Overall cavity use

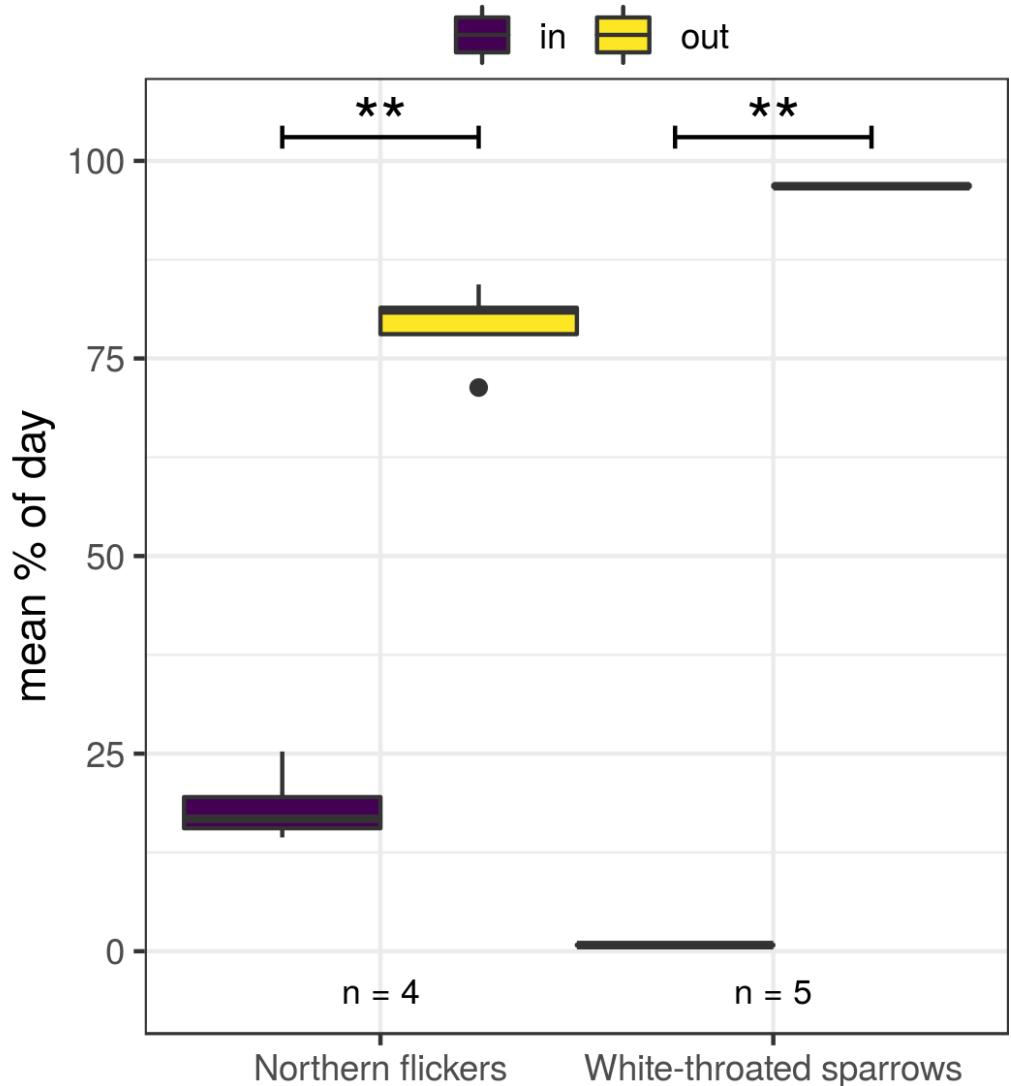


# Daytime: Results

@steffilazerte

## a) Overall cavity use

- Both spend more time outside than inside cavities

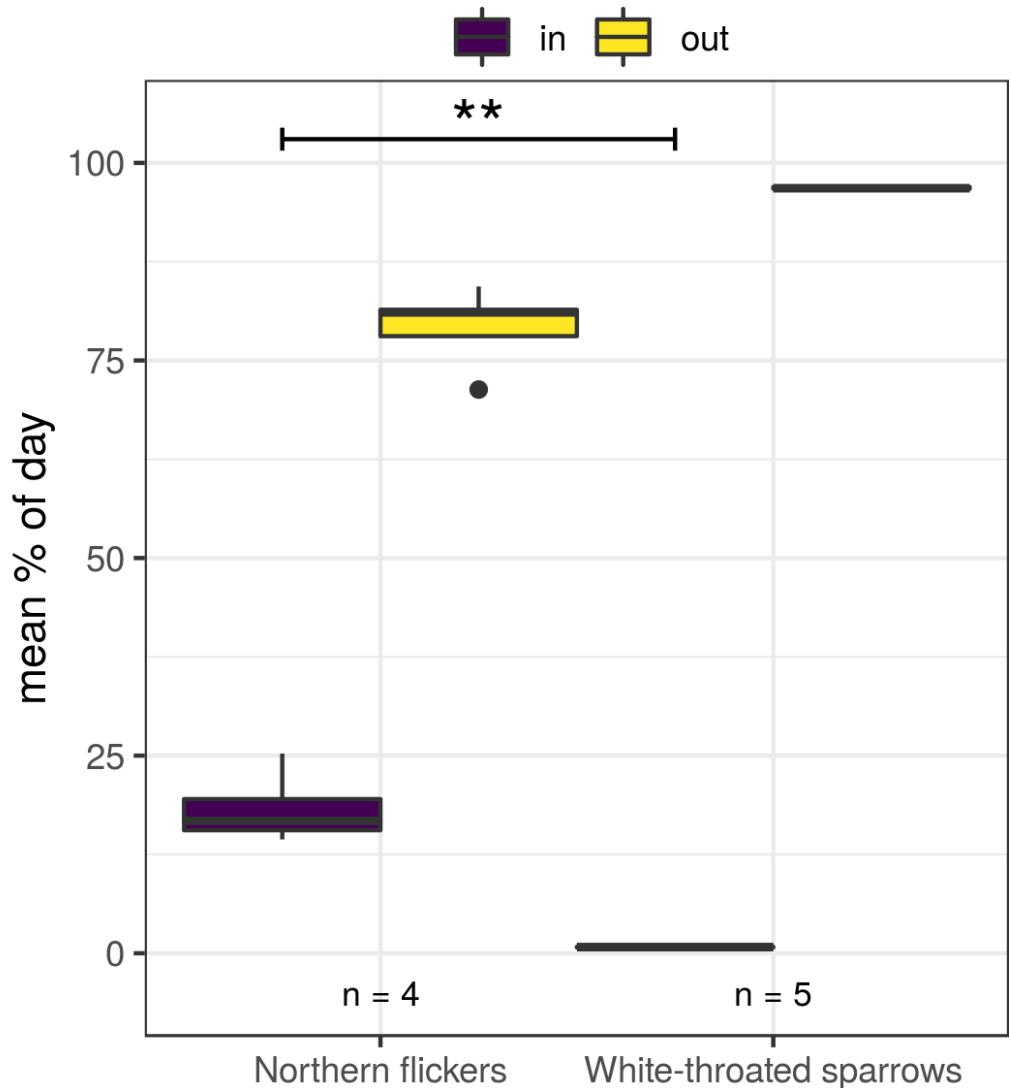


# Daytime: Results

@steffilazerte

## a) Overall cavity use

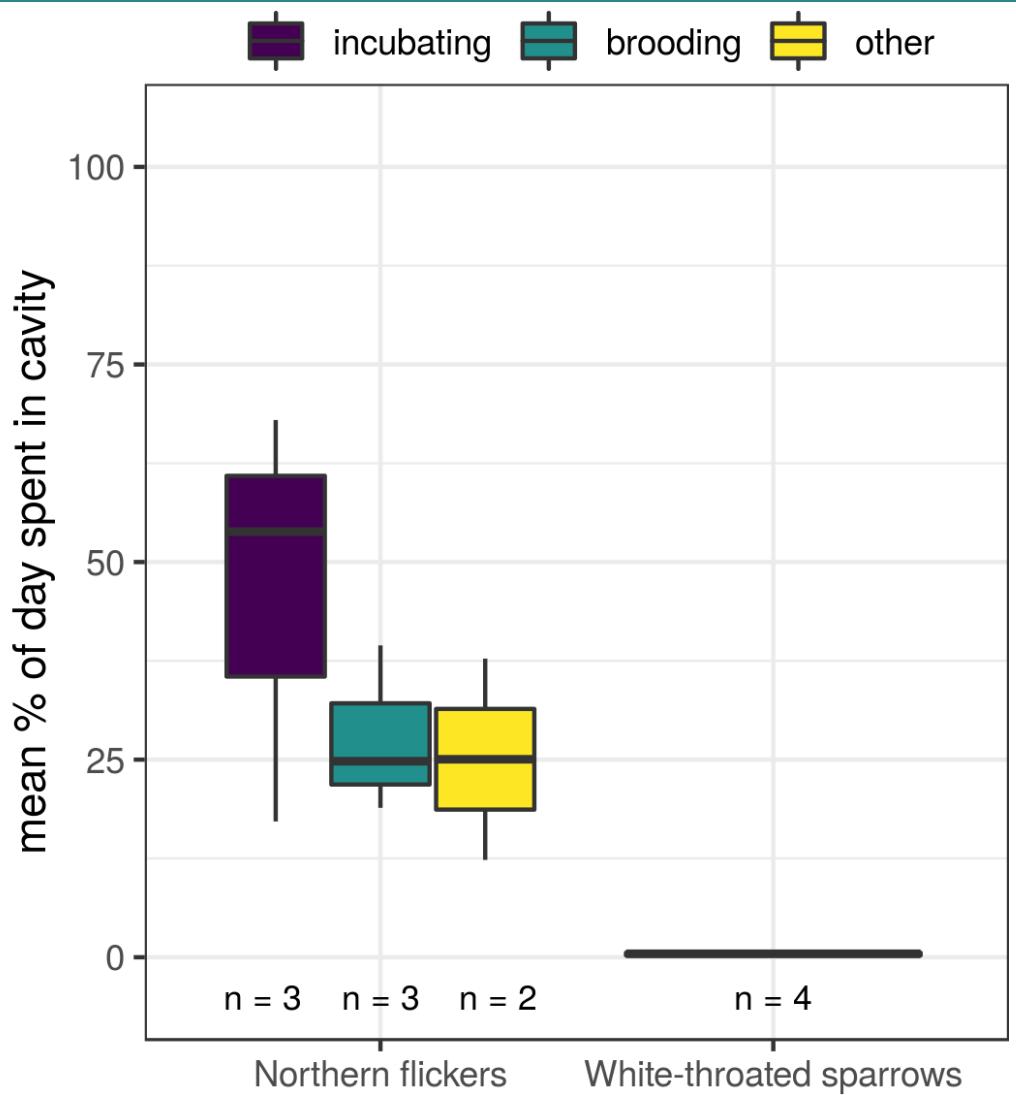
- Both spend more time outside than inside cavities
- Flickers spend more time inside than Sparrows



# Daytime: Results

@steffilazerte

## b) Incubation cavity use

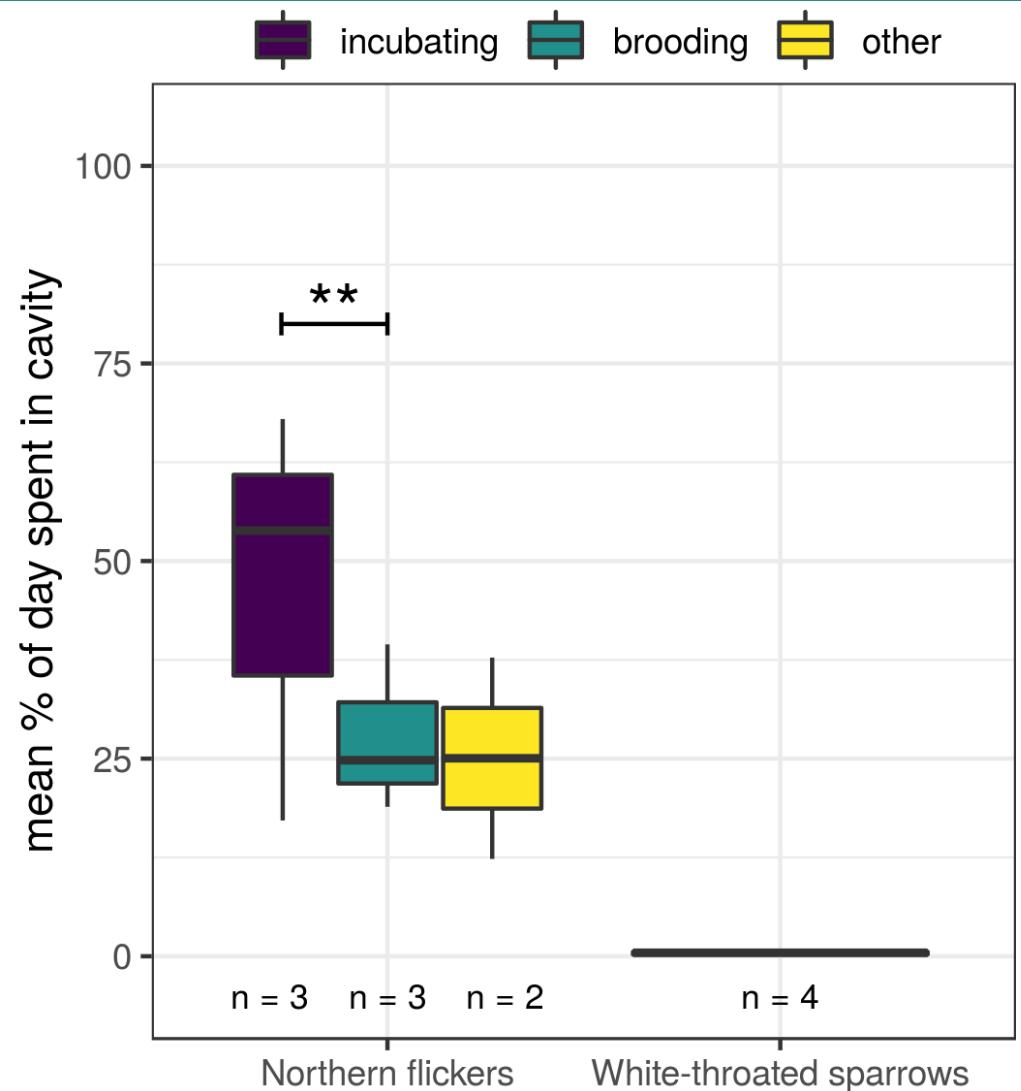


# Daytime: Results

@steffilazerte

## b) Incubation cavity use

- Incubating flickers use cavities more than
  - Brooding flickers

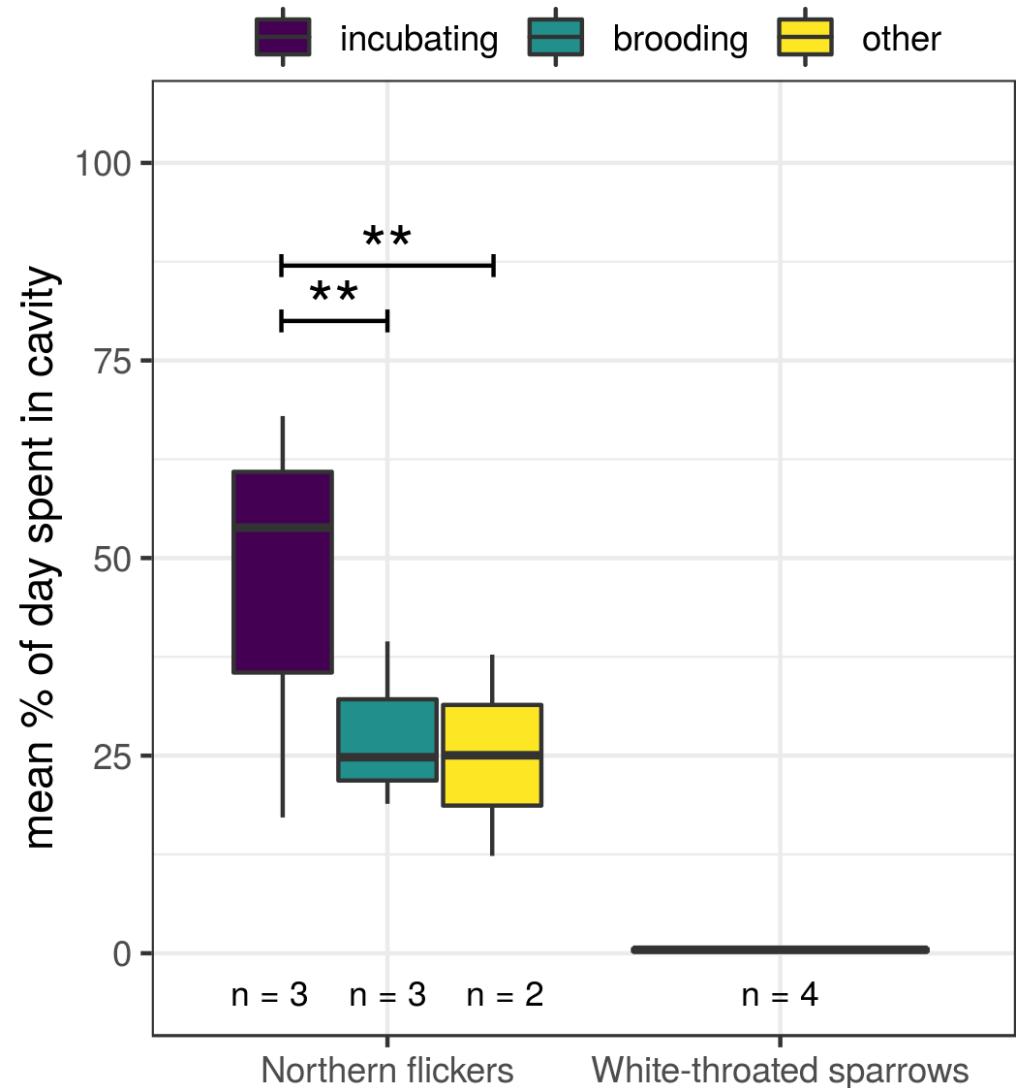


# Daytime: Results

@steffilazerte

## b) Incubation cavity use

- Incubating flickers use cavities more than
  - Brooding flickers
  - Other flickers (without eggs or nestlings)

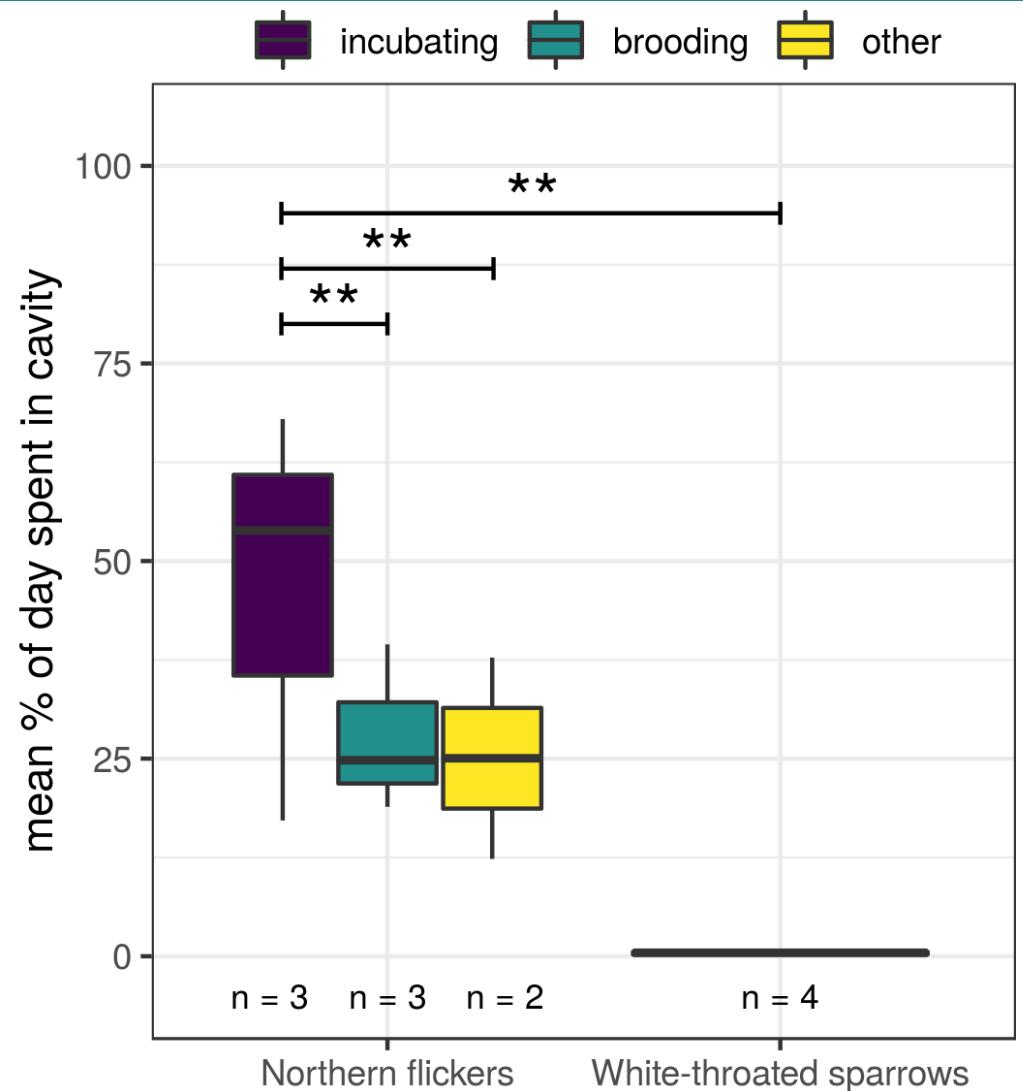


# Daytime: Results

@steffilazerte

## b) Incubation cavity use

- Incubating flickers use cavities more than
  - Brooding flickers
  - Other flickers (without eggs or nestlings)
  - Sparrows

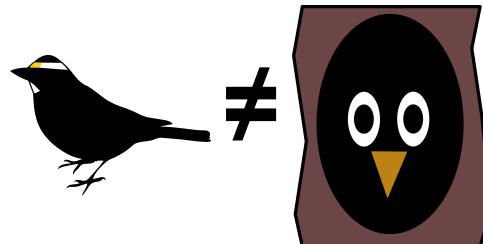


# Nighttime: Hypotheses

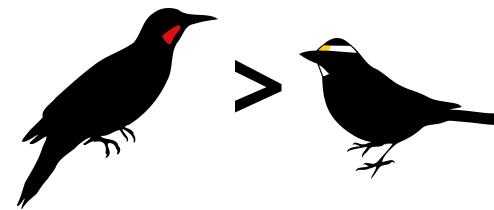
@steffilazerte

## a) Overall cavity use

Sparrows do not use cavities



Flickers use cavities more than Sparrows

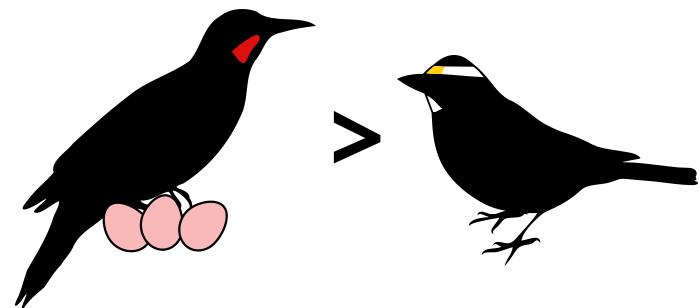
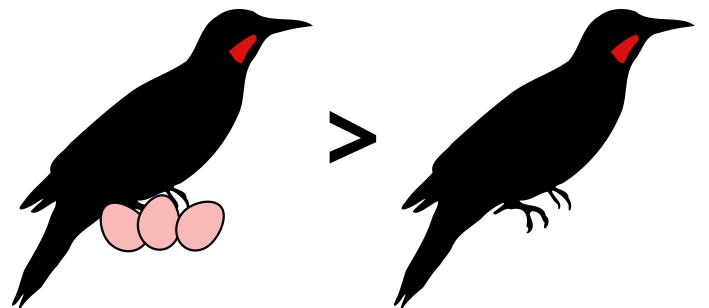


# Nighttime: Hypotheses

@steffilazerte

## b) Incubation/Brooding cavity use

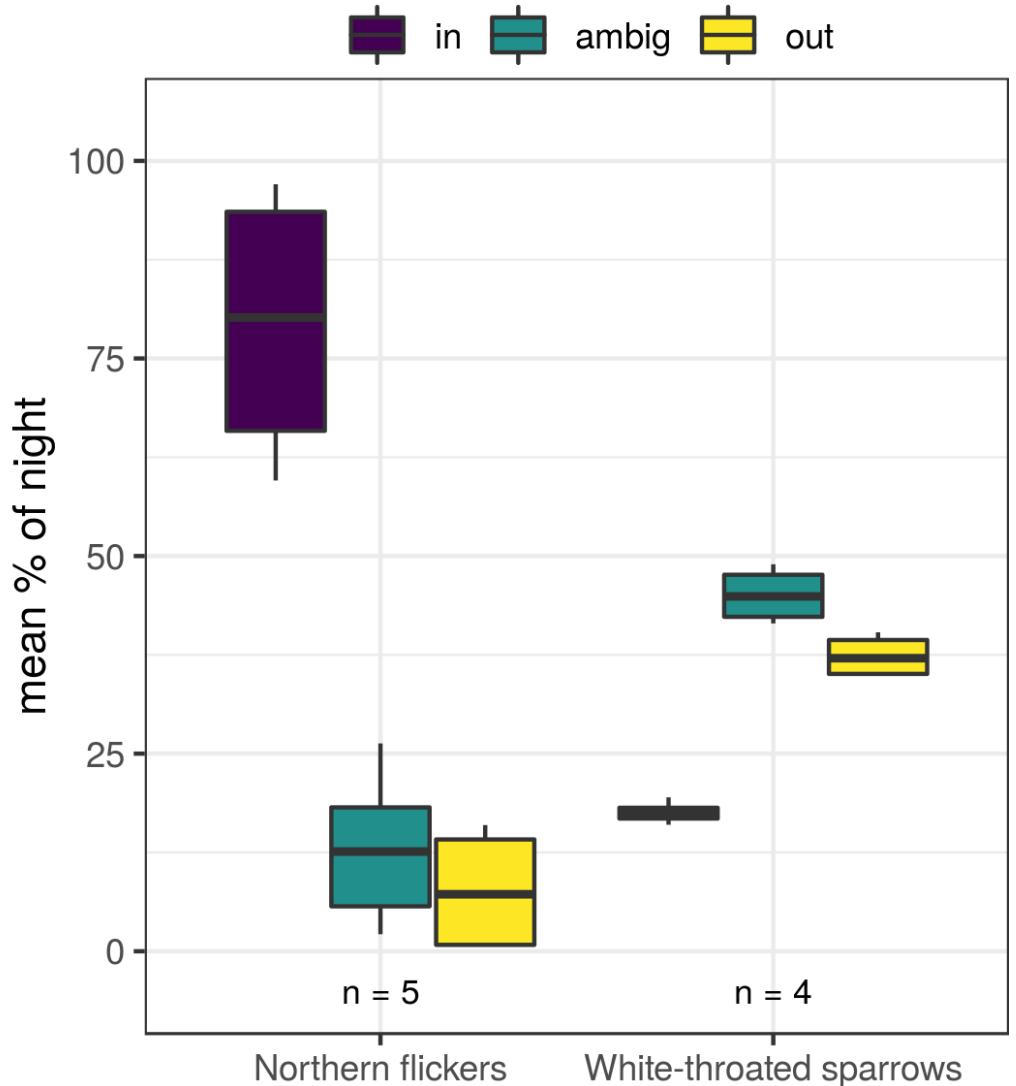
Incubating (with eggs) and Brooding (with nestlings) flickers use cavities more than Non-Incubating/Brooding (Other) flickers & Sparrows



# Nighttime: Results

@steffilazerte

## a) Overall cavity use

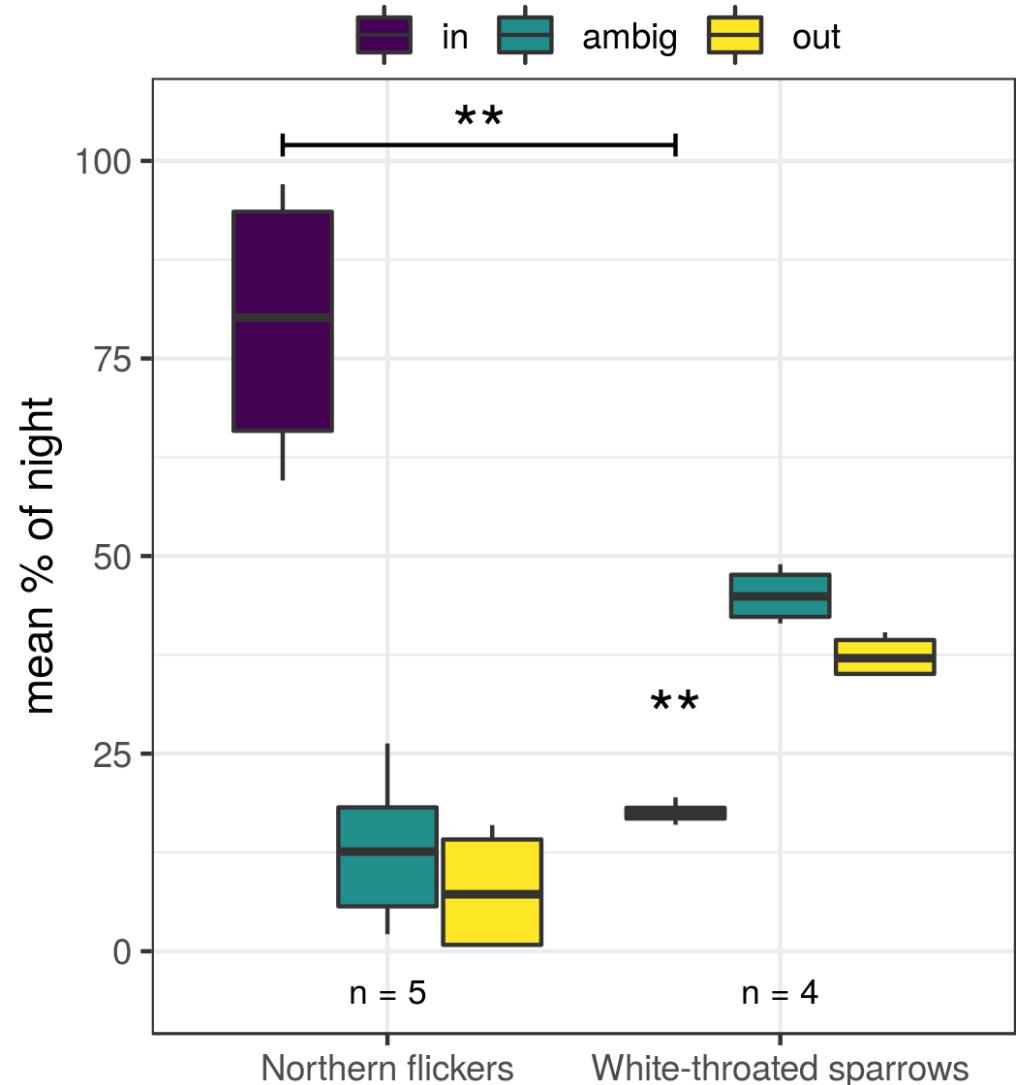


# Nighttime: Results

@steffilazerte

## a) Overall cavity use

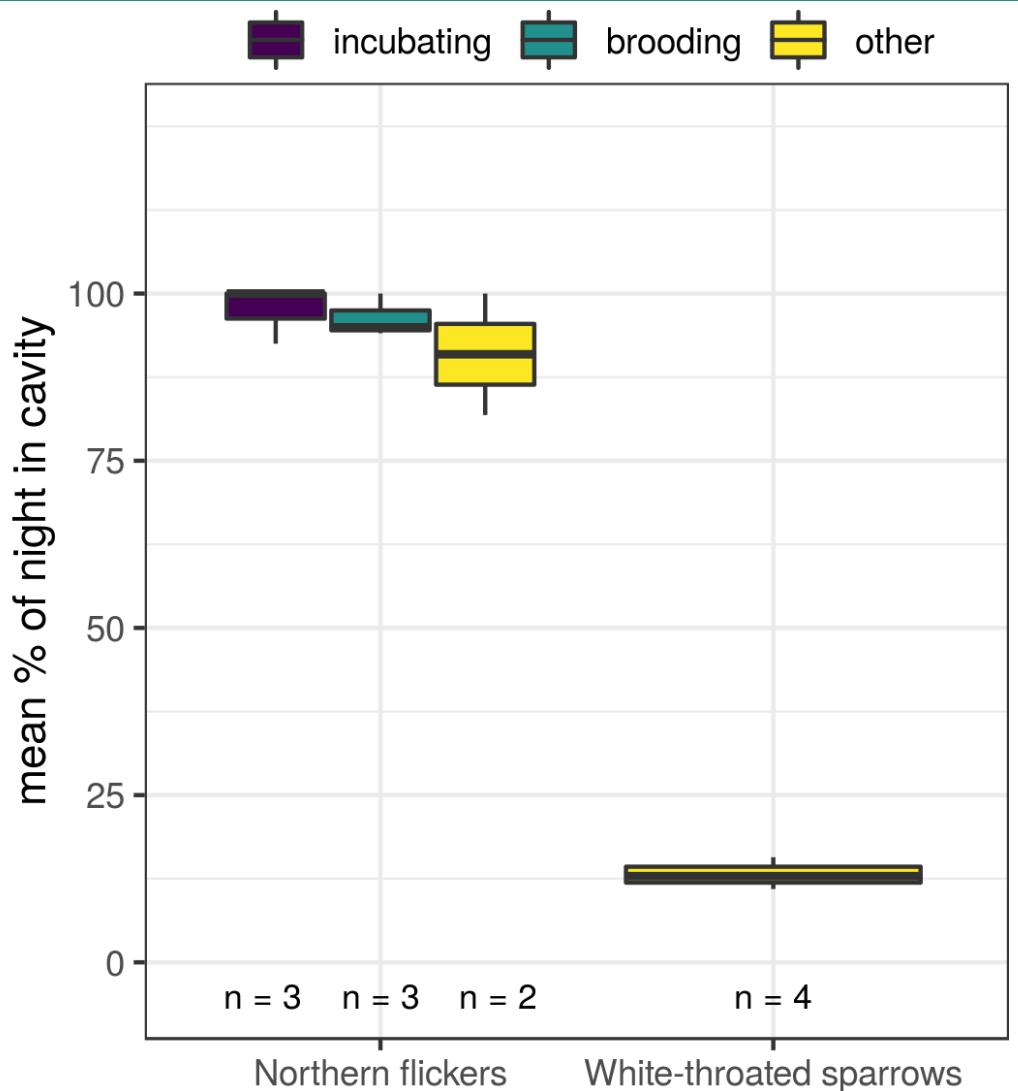
- Flickers use cavities more than Sparrows
- Sparrows **do** use cavities at night (?)



# Nighttime: Results

@steffilazerte

## b) Incubation/Brooding cavity use



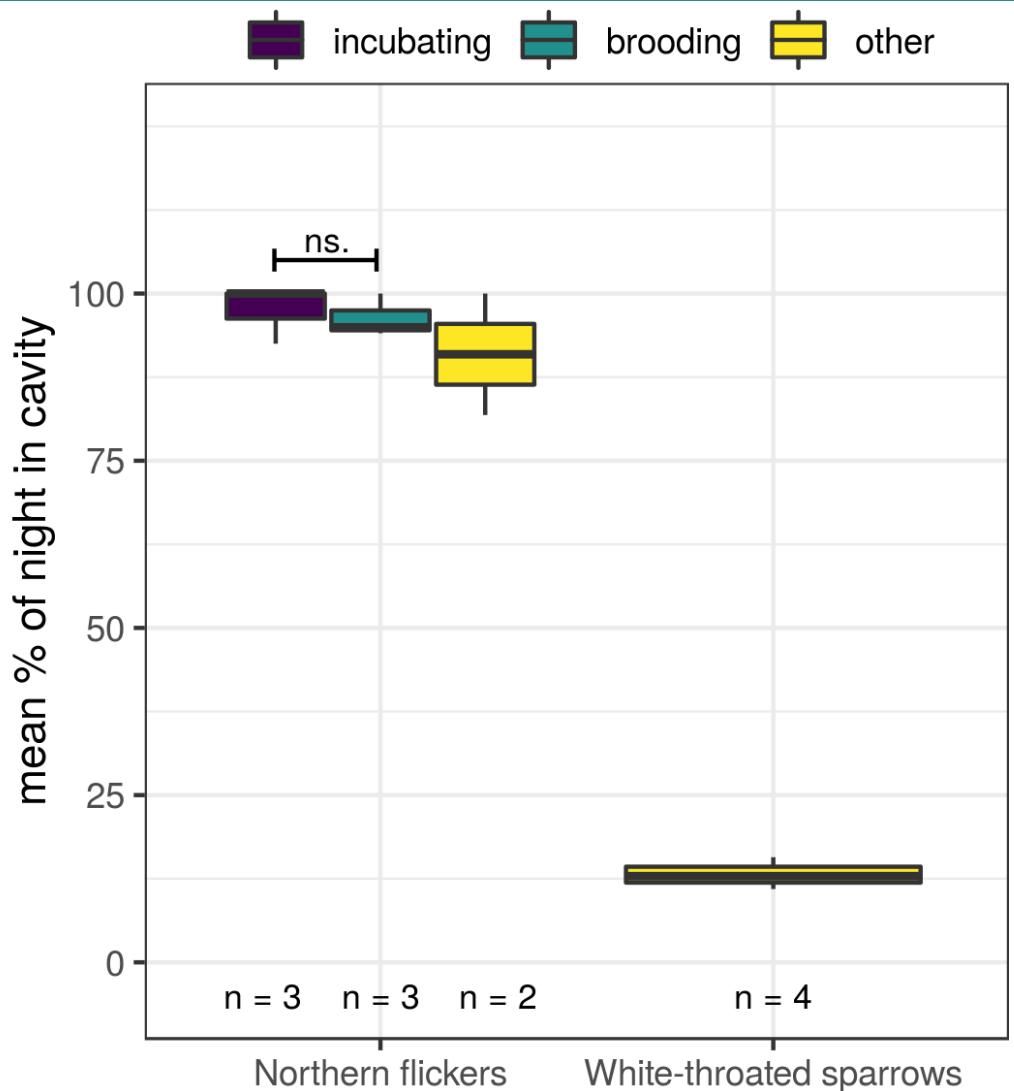
# Nighttime: Results

@steffilazerte

## b) Incubation/Brooding cavity use

Incubating and Brooding flickers:

- Have similar cavity use



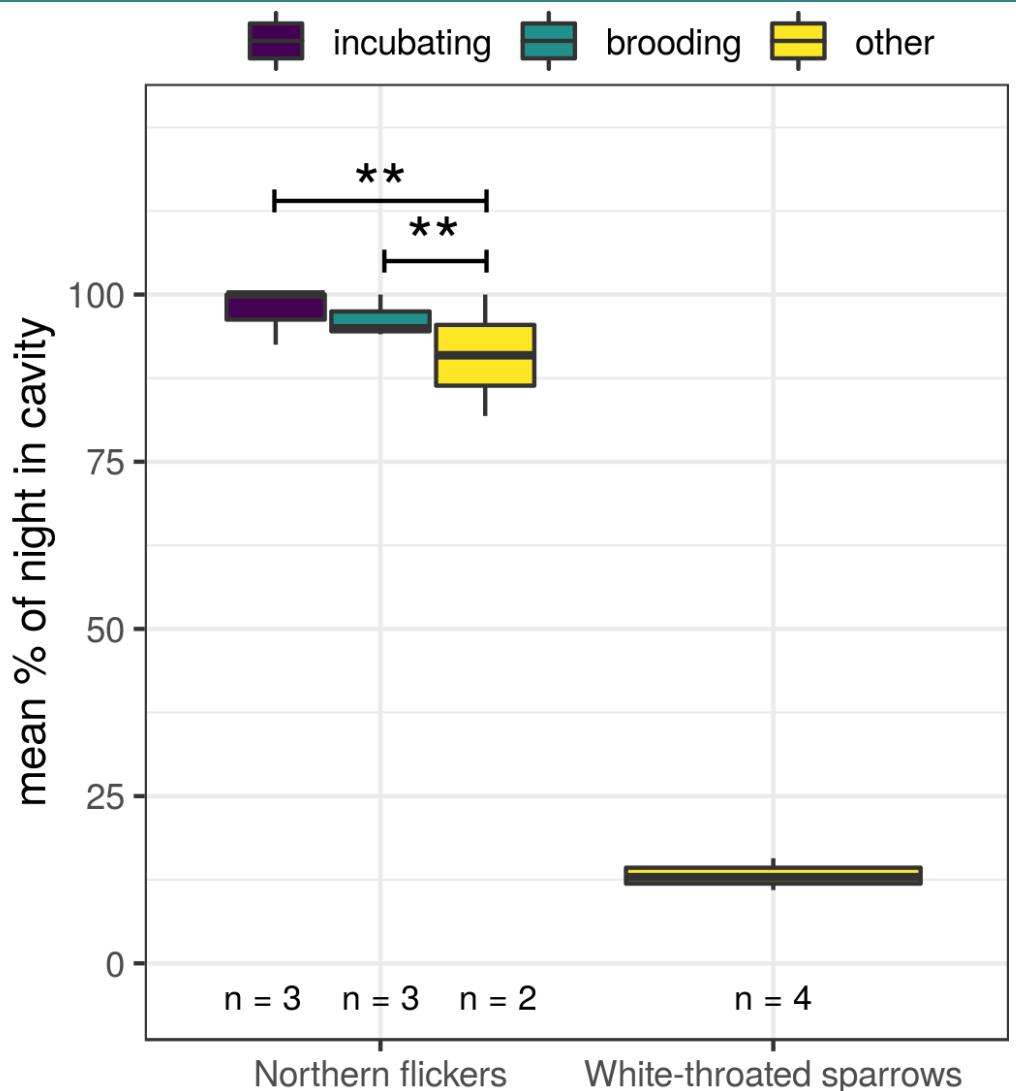
# Nighttime: Results

@steffilazerte

## b) Incubation/Brooding cavity use

Incubating and Brooding flickers:

- Have similar cavity use
- Use cavities more than Other flickers



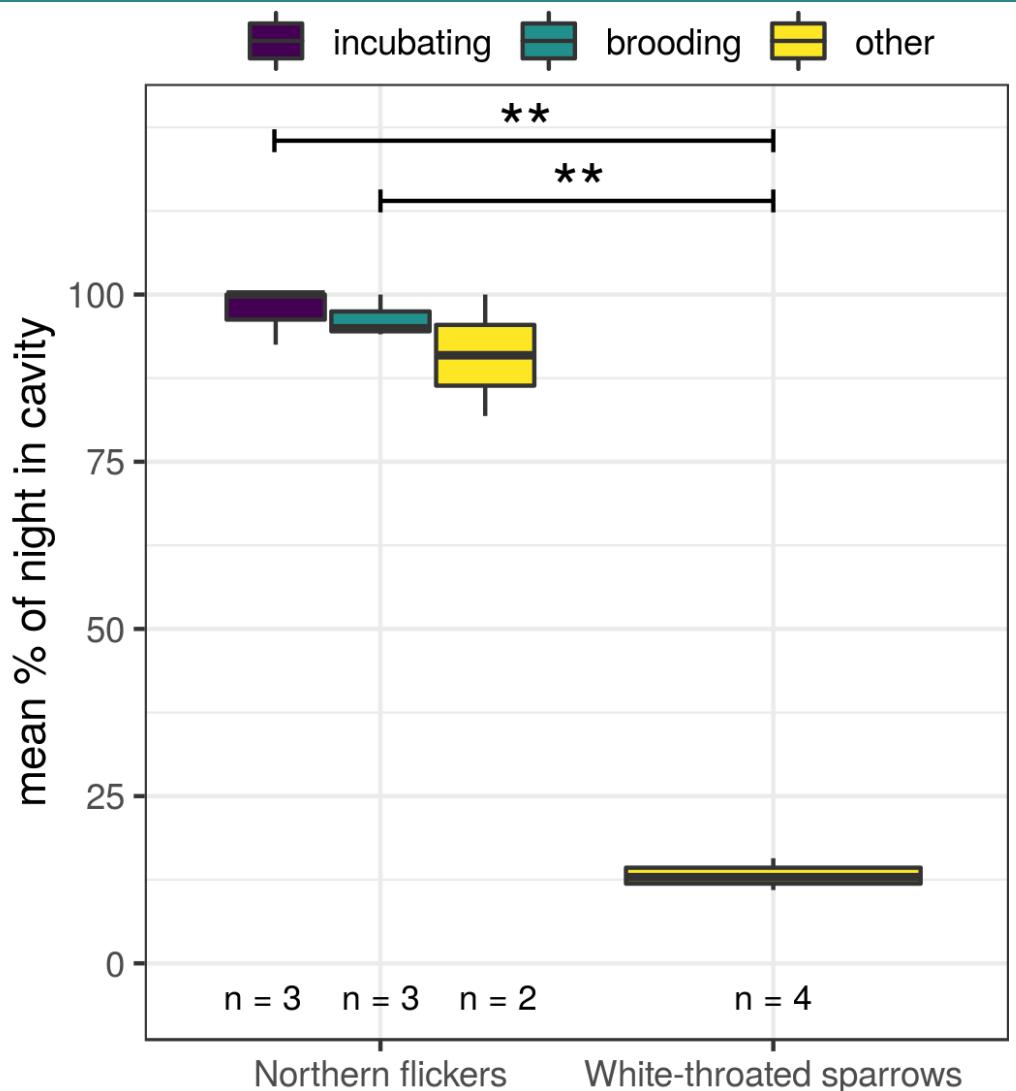
# Nighttime: Results

@steffilazerte

## b) Incubation/Brooding cavity use

Incubating and Brooding flickers:

- Have similar cavity use
- Use cavities more than Other flickers
- Use cavities more than Sparrows



# Comparing computers and humans

@steffilazerte

Gow et al. 2015

- Measured nighttime cavity use in flickers
- Scored use by hand

cavityuse

- Scored by computer



international journal of avian science

*Ibis* (2015), 157, 167–170

Short communication

## Cavity use throughout the annual cycle of a migratory woodpecker revealed by geolocators

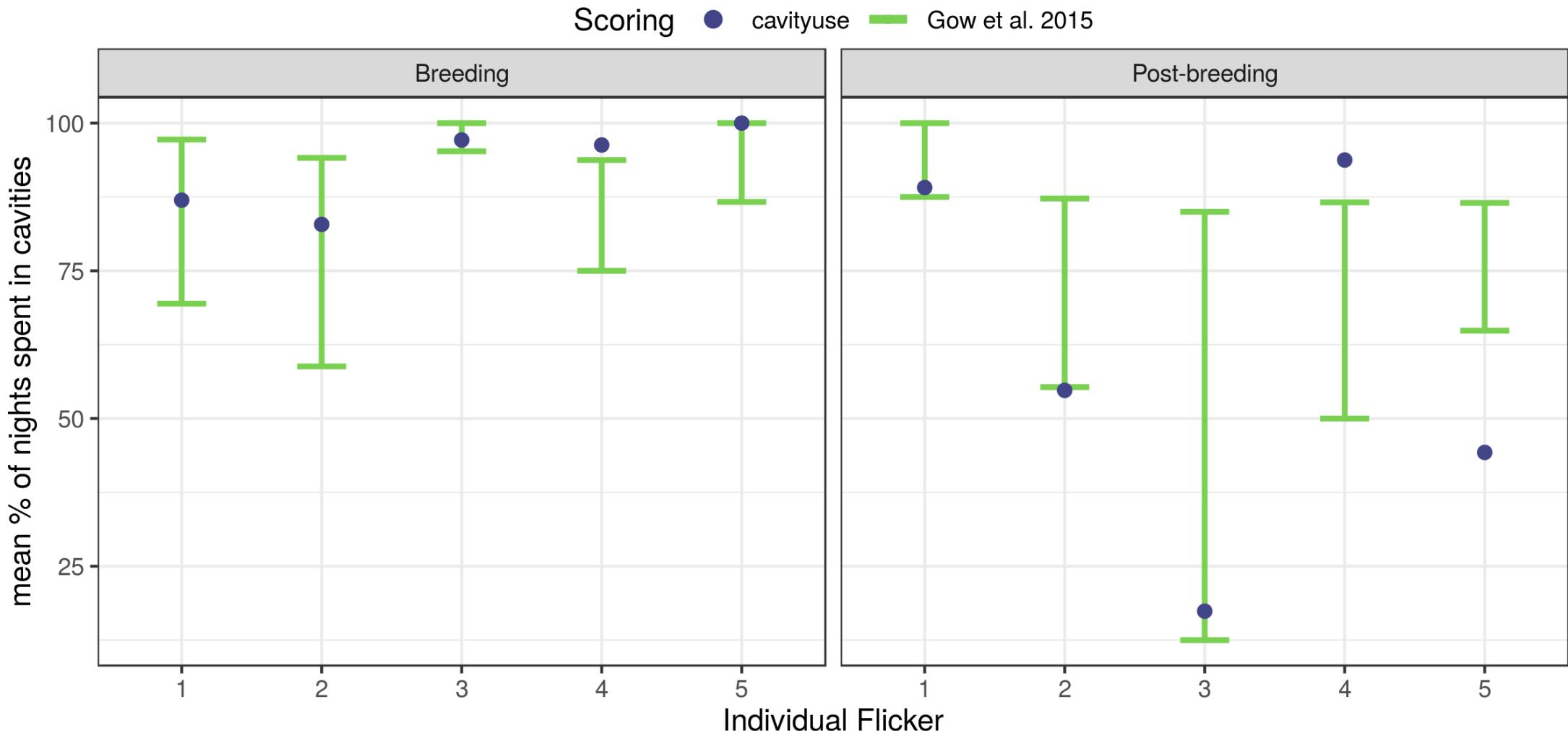
ELIZABETH A. GOW,<sup>1\*</sup> KAREN L. WIEBE<sup>1</sup> & JAMES W. FOX<sup>2†</sup>

<sup>1</sup>Department of Biology, University of Saskatchewan,  
112 Science Place, Saskatoon, SK, S7N 5E2, Canada

<sup>2</sup>British Antarctic Survey, High Cross, Madingley Road,  
Cambridge CB3 0ET, UK

# Comparing computers and humans

@steffilazerte



# cavityuse Conclusions

@steffilazerte

Results match expectations:



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

Results match expectations:

- Overall daytime cavity use



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

## Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use
- Behaviour
  - Cavity-users vs. Noncavity-users
  - Breeding cavity use



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

## Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use
- Behaviour
  - Cavity-users vs. Noncavity-users
  - Breeding cavity use
- Computer- vs. Human-scored



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

## Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use
- Behaviour
  - Cavity-users vs. Noncavity-users
  - Breeding cavity use
- Computer- vs. Human-scored

## Results don't match expectations:

- Overall nighttime cavity use



Pwieland via Wikimedia Commons

# cavityuse Conclusions

@steffilazerte

## Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use
- Behaviour
  - Cavity-users vs. Noncavity-users
  - Breeding cavity use
- Computer- vs. Human-scored

## Results don't match expectations:

- Overall nighttime cavity use

Good for daytime behaviour



Pwieland via Wikimedia Commons

# What next?

@steffilazerte

- Improve nighttime detections
  - Detect more types of light transitions



H. Zell via Wikimedia Commons

# What next?

@steffilazerte

- Improve nighttime detections
  - Detect more types of light transitions
- Test different applications
  - Different species (swifts? bats? squirrels?)
  - Different cavities (chimneys? caves? burrows?)
  - Different behaviour (shorebird incubation?)



H. Zell via Wikimedia Commons

# What next?

@steffilazerte

- Improve nighttime detections
  - Detect more types of light transitions
- Test different applications
  - Different species (swifts? bats? squirrels?)
  - Different cavities (chimneys? caves? burrows?)
  - Different behaviour (shorebird incubation?)
- Compare to ground observations



H. Zell via Wikimedia Commons

# What next?

@steffilazerte

- Improve nighttime detections
  - Detect more types of light transitions
- Test different applications
  - Different species (swifts? bats? squirrels?)
  - Different cavities (chimneys? caves? burrows?)
  - Different behaviour (shorebird incubation?)
- Compare to ground observations

**Ground truthing!**



H. Zell via Wikimedia Commons

# Check out cavityuse

@steffilazerte

Openly developed on GitHub : <http://github.com/steffilazerte/cavityuse>

- How to download/install cavityuse
- How to use cavityuse
- Contribution (feature-requests, bugs, code!)

# Check out cavityuse

@steffilazerte

Openly developed on GitHub : <http://github.com/steffilazerte/cavityuse>

- How to download/install cavityuse
- How to use cavityuse
- Contribution (feature-requests, bugs, code!)

## Thanks!



Presentation Available: <https://steffilazerte.github.io/Presentations/>

Slides created with the R package [xaringan](#), using [remark.js](#), [knitr](#), and [R Markdown](#)

Compiled on 2018-08-10 with cavityuse v0.1.0



Dr. Steffi LaZerte  
Analysis and Data Tools for Science



[steffilazerte.ca](http://steffilazerte.ca)   
[sel@steffilazerte.ca](mailto:sel@steffilazerte.ca) 



# References

@steffilazerte

- Burger J, Niles LJ, Porter RR, Dey AD (2012). Using geolocator data to reveal incubation periods and breeding biology in Red Knots *Calidris canutus rufa*. Wader Study Group Bull, 119:26-36. <http://www.waderstudygroup.org/article/1890/>
- Cory TW, Wilsterman K, Kelley AD, Breton AR, Stark H, Humphries MM, McAdam AG, Barnes BM, Boutin S, Buck CL (2014). Light loggers reveal weather-driven changes in the daily activity patterns of arboreal and semifossorial rodents. Journal of Mammalogy, 95: Pages 1230-1239. <https://doi.org/10.1644/14-MAMM-A-062>
- Gow EA, Wiebe KL, Fox JW (2015). Cavity use throughout the annual cycle of a migratory woodpecker revealed by geolocators. Ibis, 157:167-170. <https://doi.org/10.1111/ibi.12206>
- Otter KA, Mckenna A, LaZerte SE, Ramsay SM (2017).The possible link between wintering grounds and continent-wide shifts in song dialects of white-throated sparrows (Oral). The joint meeting of the American Ornithological Society and the Society of Canadian Ornithologists/Société des ornithologistes du Canada (East Lansing, MI, USA).

# Monitoring cavity use

@steffilazerte

## At the cavity

- Human observation
- Video surveillance
- Audio surveillance
- RFID loggers

## At the individual

- GPS/Accelerometers collars
- Temperature loggers
- Light loggers (i.e. geolocators)
- RFID loggers



Gertrud Nürnberg

# Monitoring cavity use

@steffilazerte

## Limitations

- Knowing where potential cavities are
- Individual vs. Group patterns
- Cost (Equipment, technicians)
- Data Processing (time, reproducibility)

# Daytime activity for white-throated sparrows

@steffilazerte

White-throated sparrows spent

- 0.8% (0.7 - 0.8) of their time Inside
- 96.9% (96.7 - 97.3) of their time Outside
- 0.8% (0 - 2.3) of their time was ambiguous

## Sunrise / Sunset Detection

- See sunset and sunrise → "Out"
- See NO sunset OR sunrise → "In"
- See either → "Ambiguous"

# Nighttime

@steffilazerte

## Sunrise / Sunset Detection

- See sunset and sunrise → "Out"
- See NO sunset OR sunrise → "In"
- See either → "Ambiguous"

## Algorithm to detect sunrise/sunset

- Data from one geolocator to create the algorithm
- Tested on 4 others
- Days of calibration data

# Nighttime

@steffilazerte

## Sunrise / Sunset Detection

- See sunset and sunrise → "Out"
- See NO sunset OR sunrise → "In"
- See either → "Ambiguous"

## Algorithm to detect sunrise/sunset

- Data from one geolocator to create the algorithm
- Tested on 4 others
- Days of calibration data

Not bad!

