

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



cavityuse

An R Package for Detecting Cavity Use From Geolocator Data

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

ISBE 2018

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Cavities, caves and burrows

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Provide

- Shelter
- Nests
- Roosts

Patterns of use indicate

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



Visitor7 via Wikimedia Commons

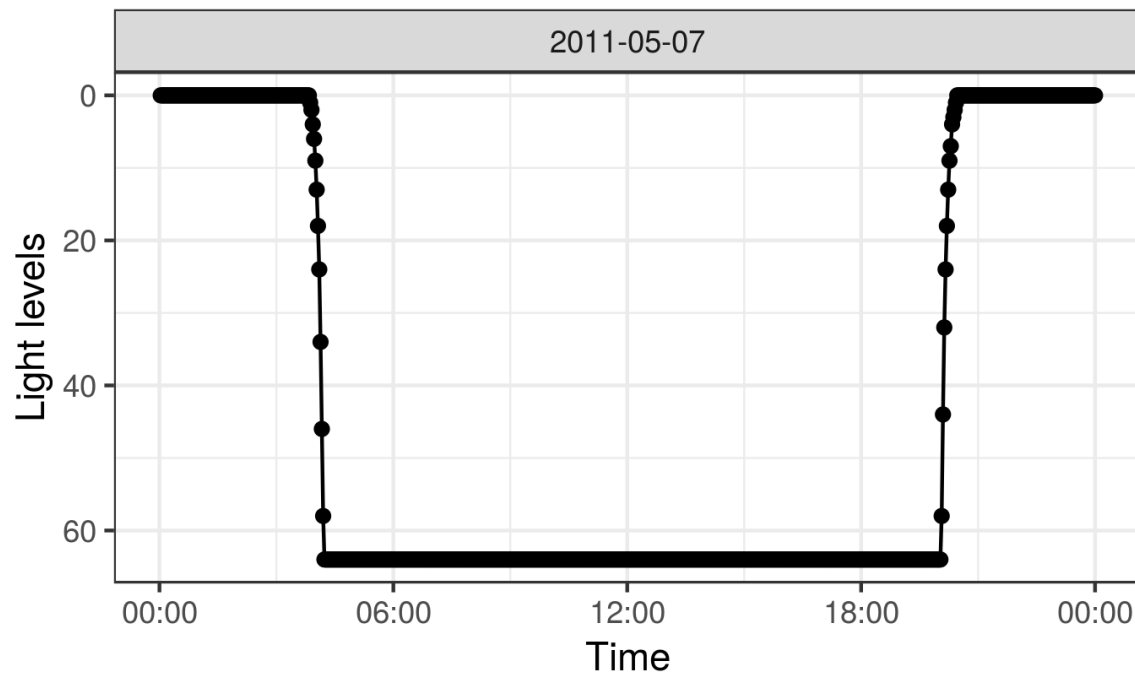
e.g., Roosting Vaux's swifts

Geolocators

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To study migration

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



Placing geolocator on white-throated sparrow

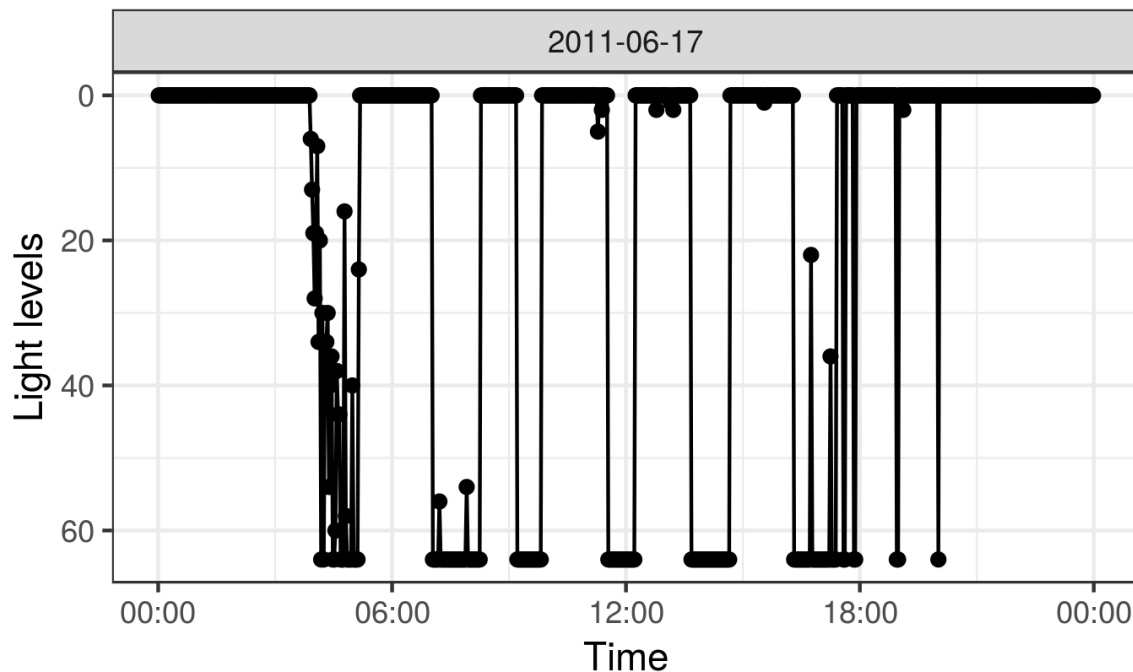
Scott Ramsay

Geolocators

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To study cavity use

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



Placing geolocator on white-throated sparrow

Scott Ramsay

Geolocators

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Benefits

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



Scott Ramsay

Placing geolocator on white-throated sparrow

Geolocators

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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

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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

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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



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

Geolocators

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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!



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

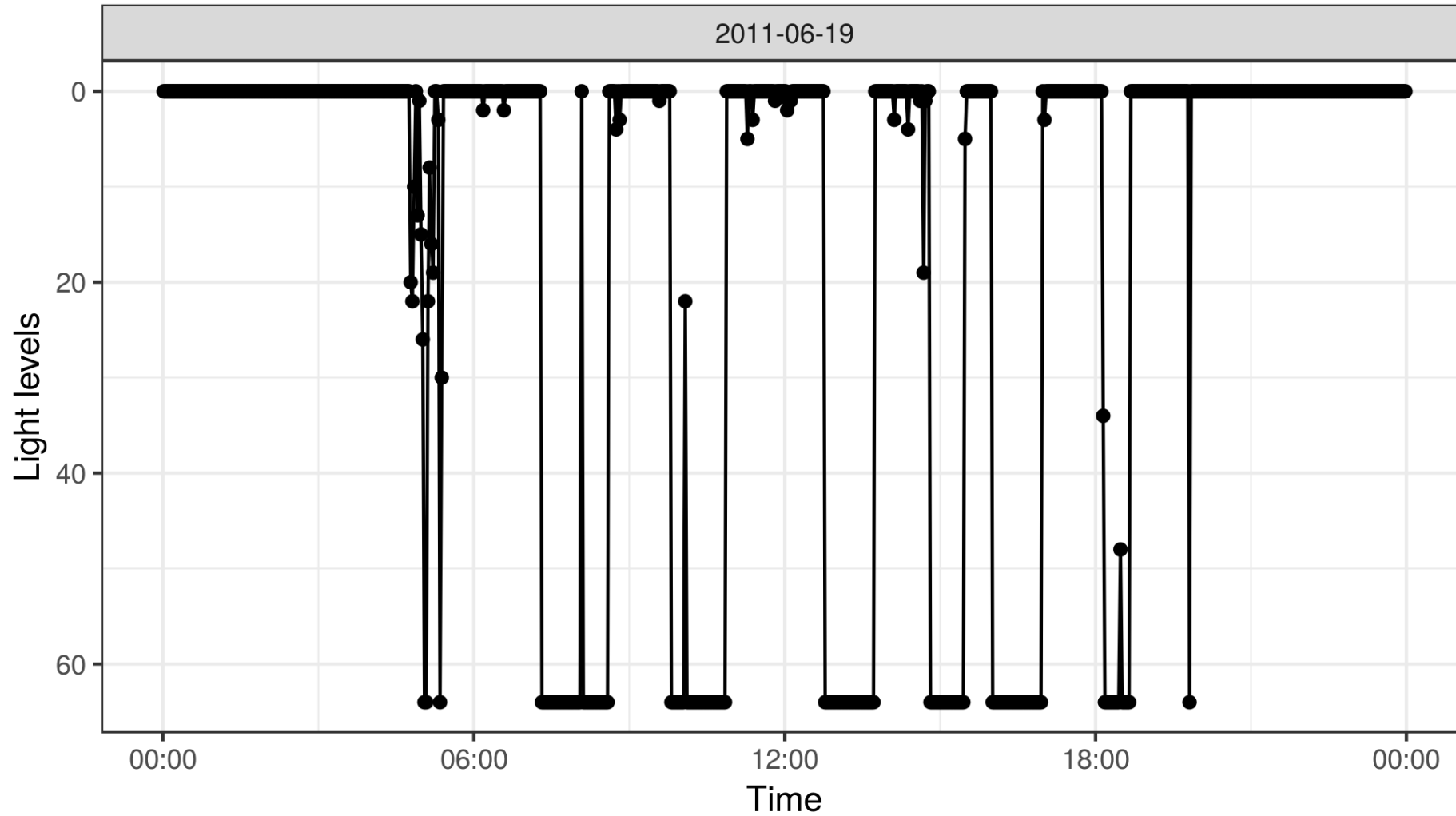
cavityuse: An R package

Leverage the power of



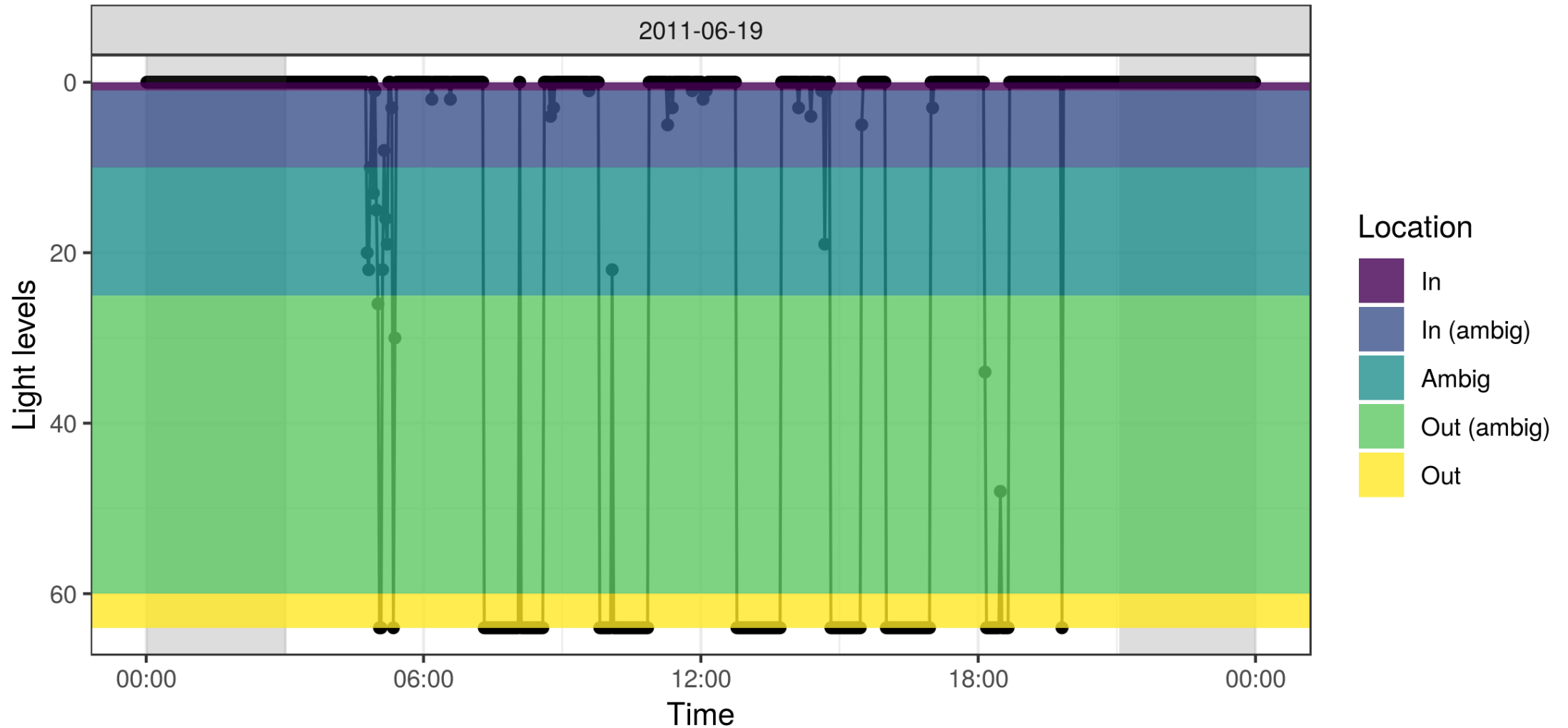
General Principles

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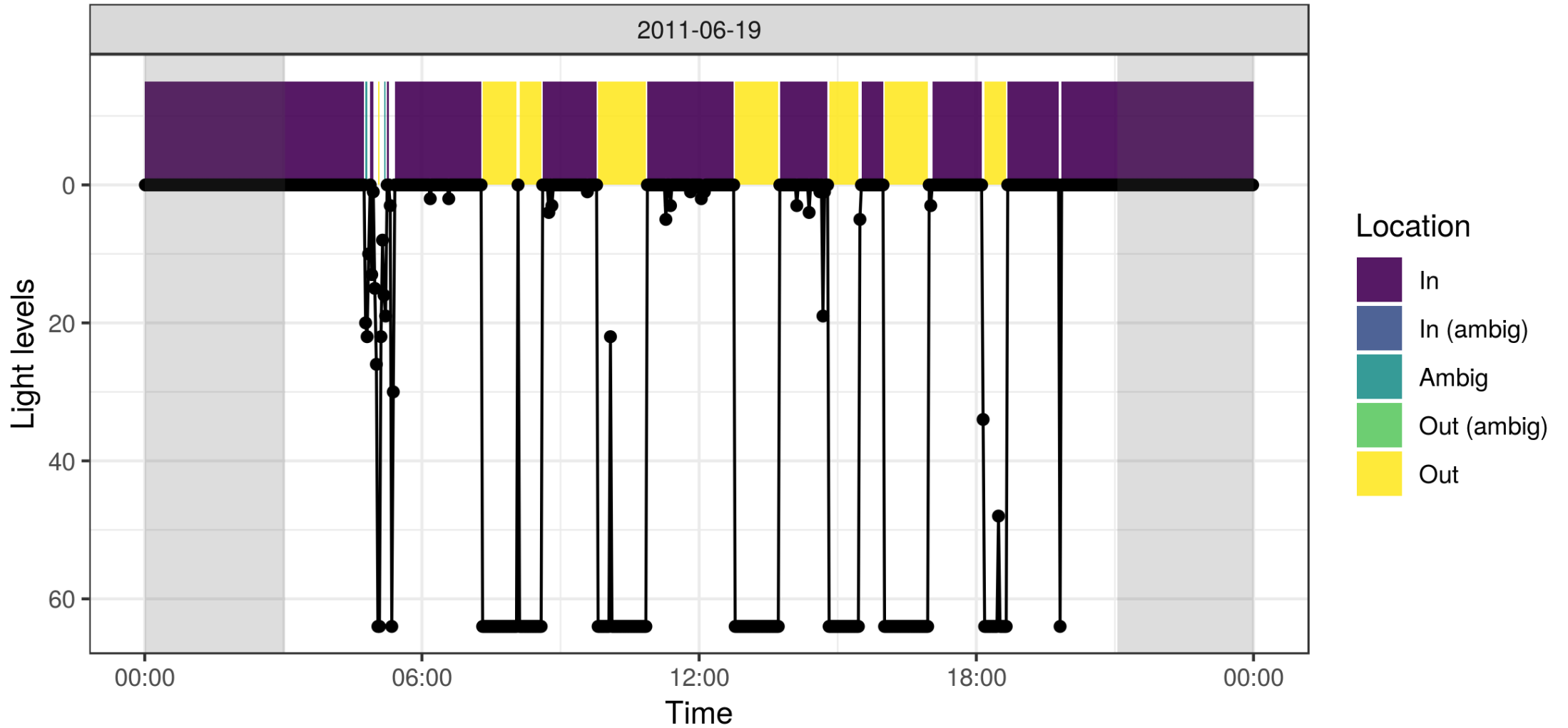
General Principles

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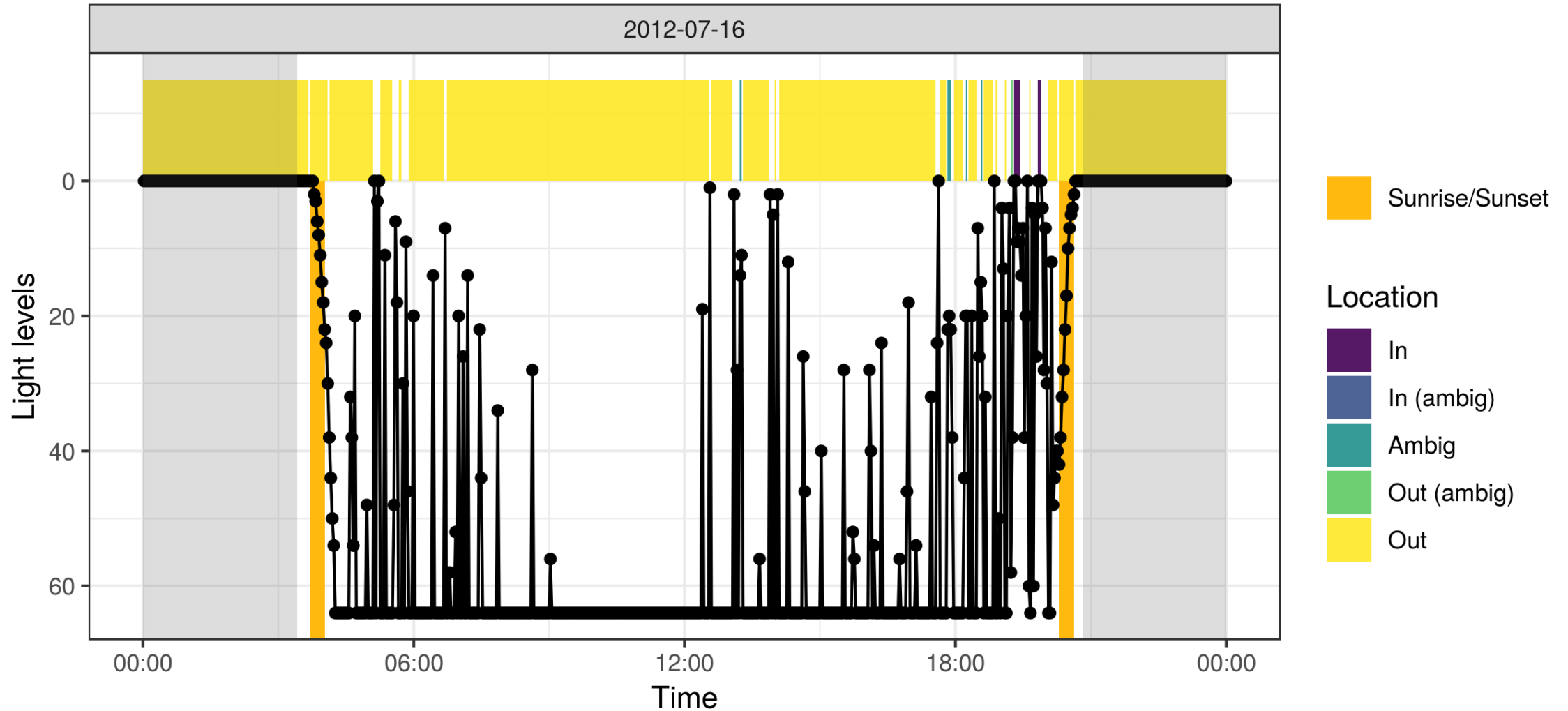
General Principles

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General Principles

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Testing cavityuse

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Elizabeth Gow

Northern flickers (*Colaptes auratus*)

Cavity nesters

Gow, Weibe & Fox; 2015 Ibis



Scott Ramsay

White-throated sparrows (*Zonotrichia albicollis*)

Ground nesters

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

Day

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



Night

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

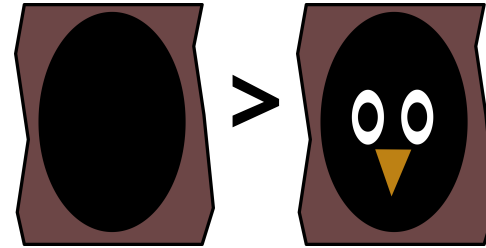


Daytime: Hypotheses

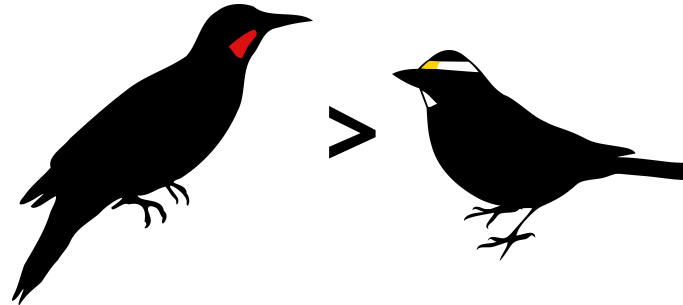
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a) Overall cavity use:

Birds spend more time outside than inside cavities



Flickers use cavities more than Sparrows

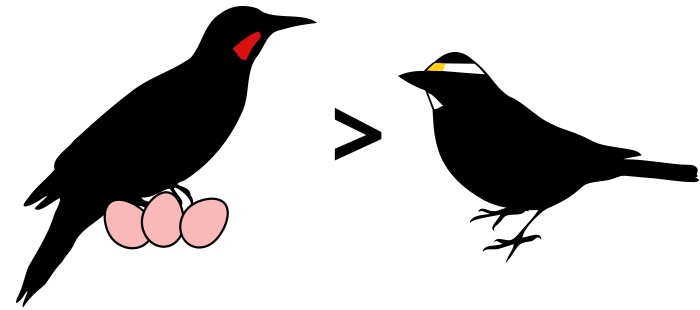
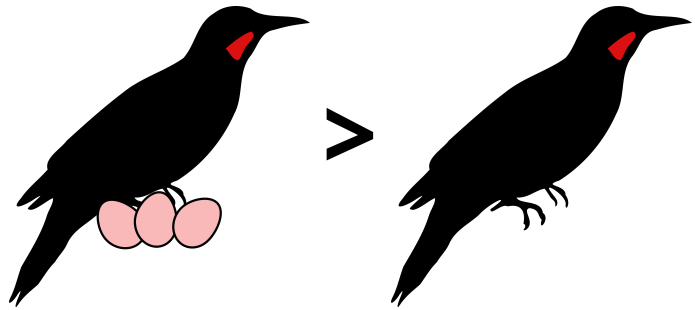


Daytime: Hypotheses

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b) Incubation cavity use:

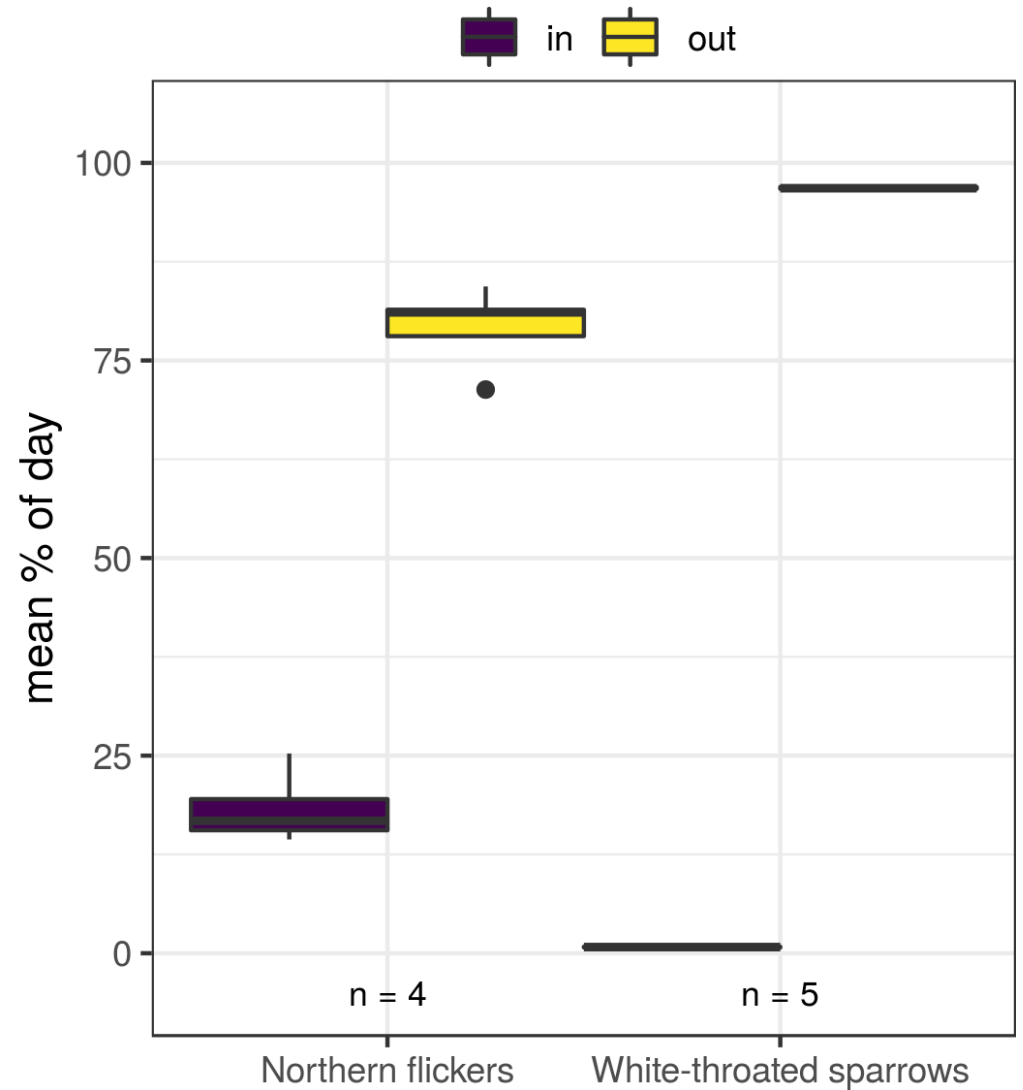
Incubating flickers use cavities more than Non-incubating (Other) flickers & Sparrows



Daytime: Results

@steffilazerte

a) Overall cavity use

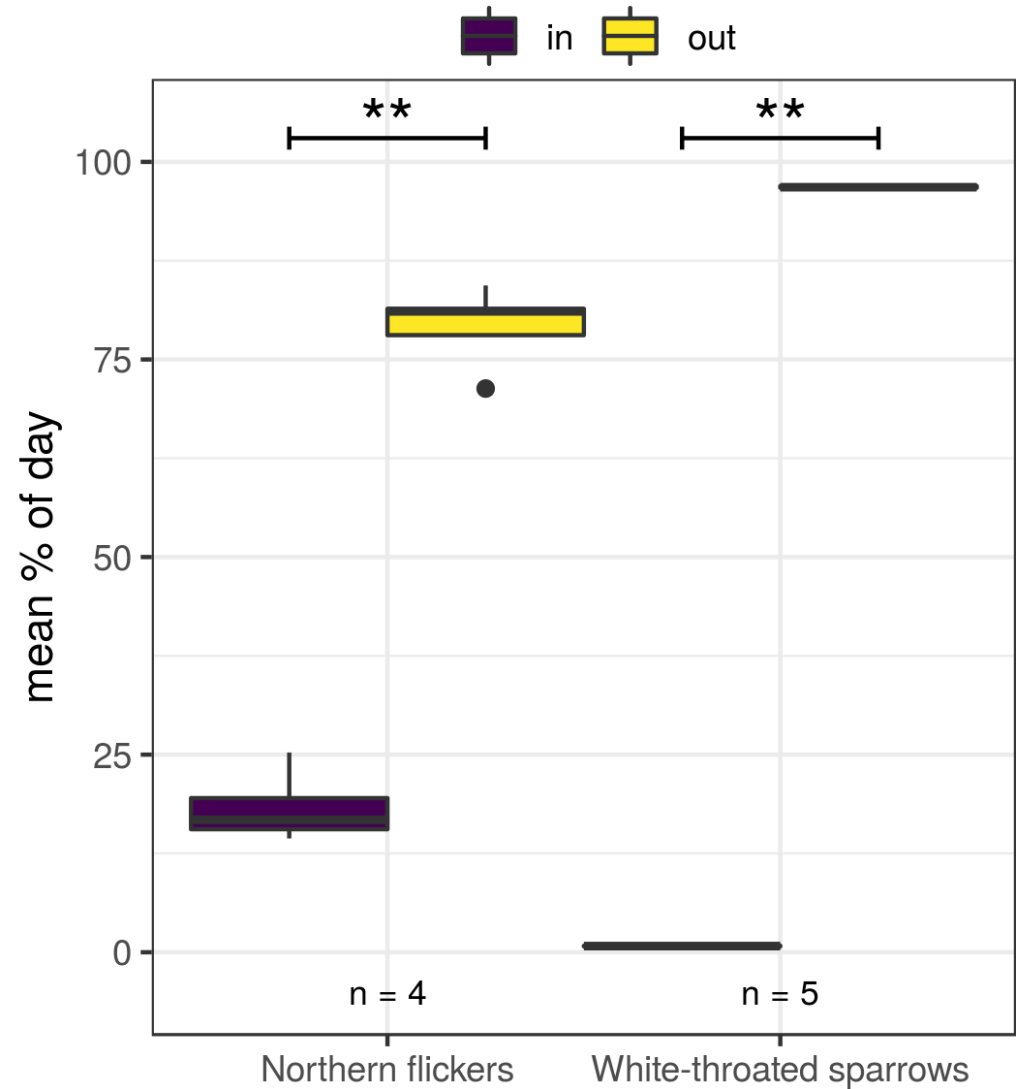


Daytime: Results

@steffilazerte

a) Overall cavity use

- Both spend more time outside than inside cavities

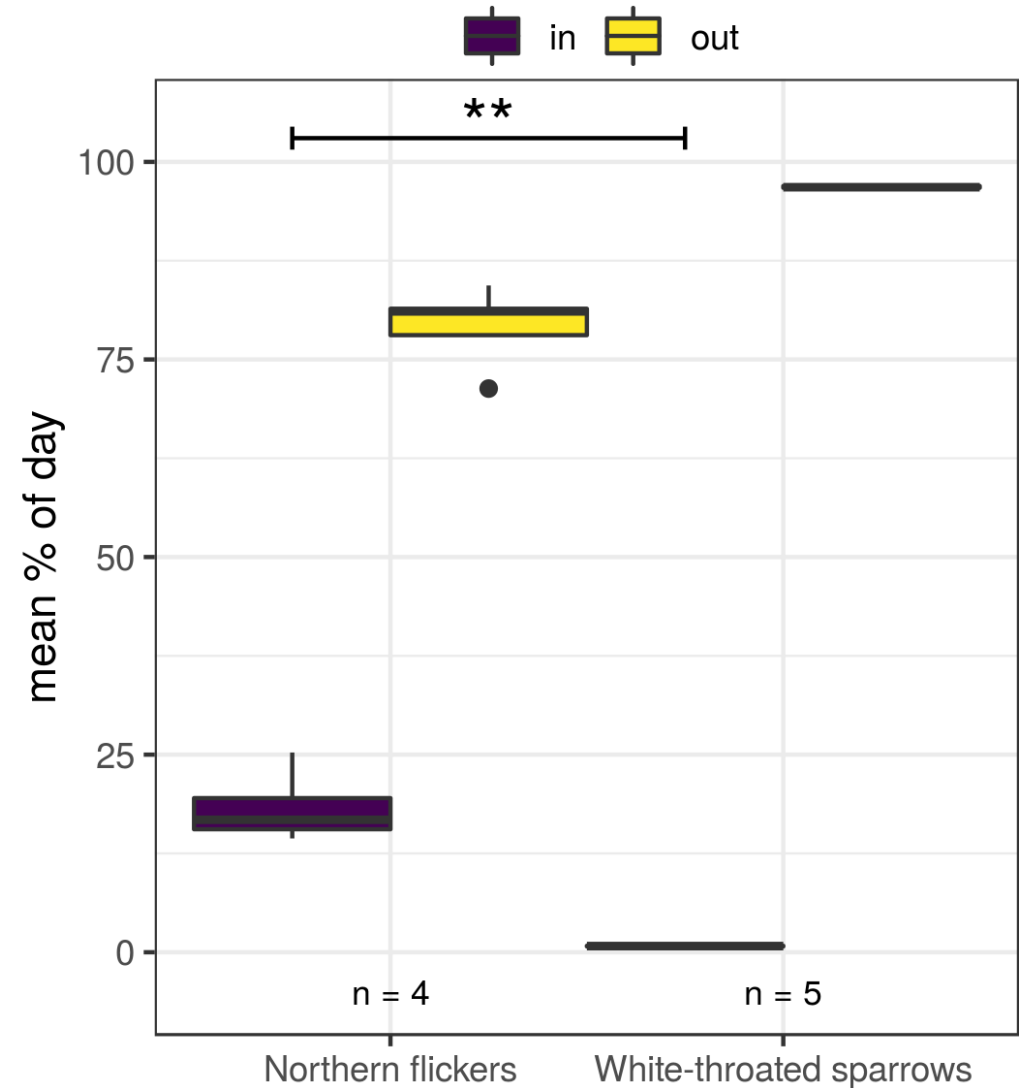


Daytime: Results

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a) Overall cavity use

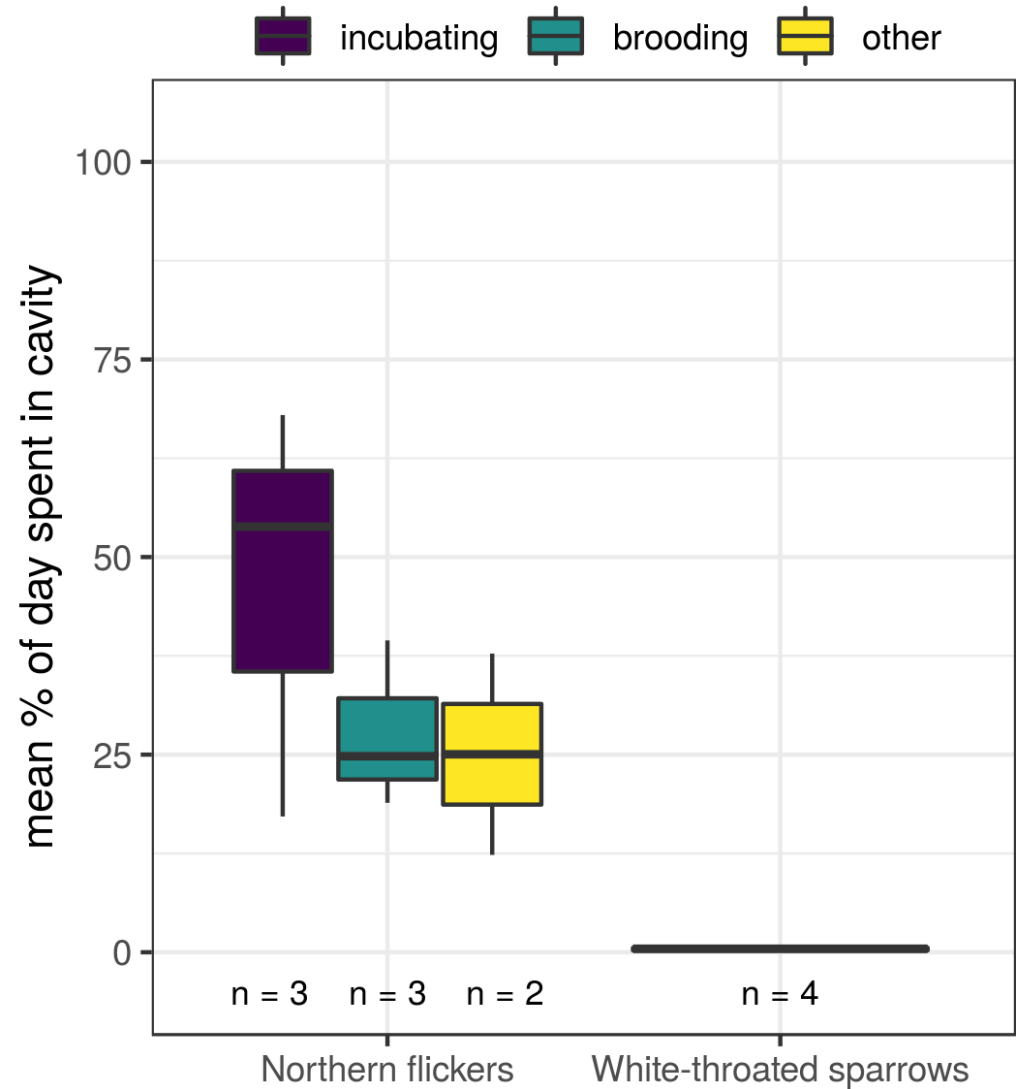
- Both spend more time outside than inside cavities
- Flickers spend more time inside than Sparrows



Daytime: Results

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b) Incubation cavity use

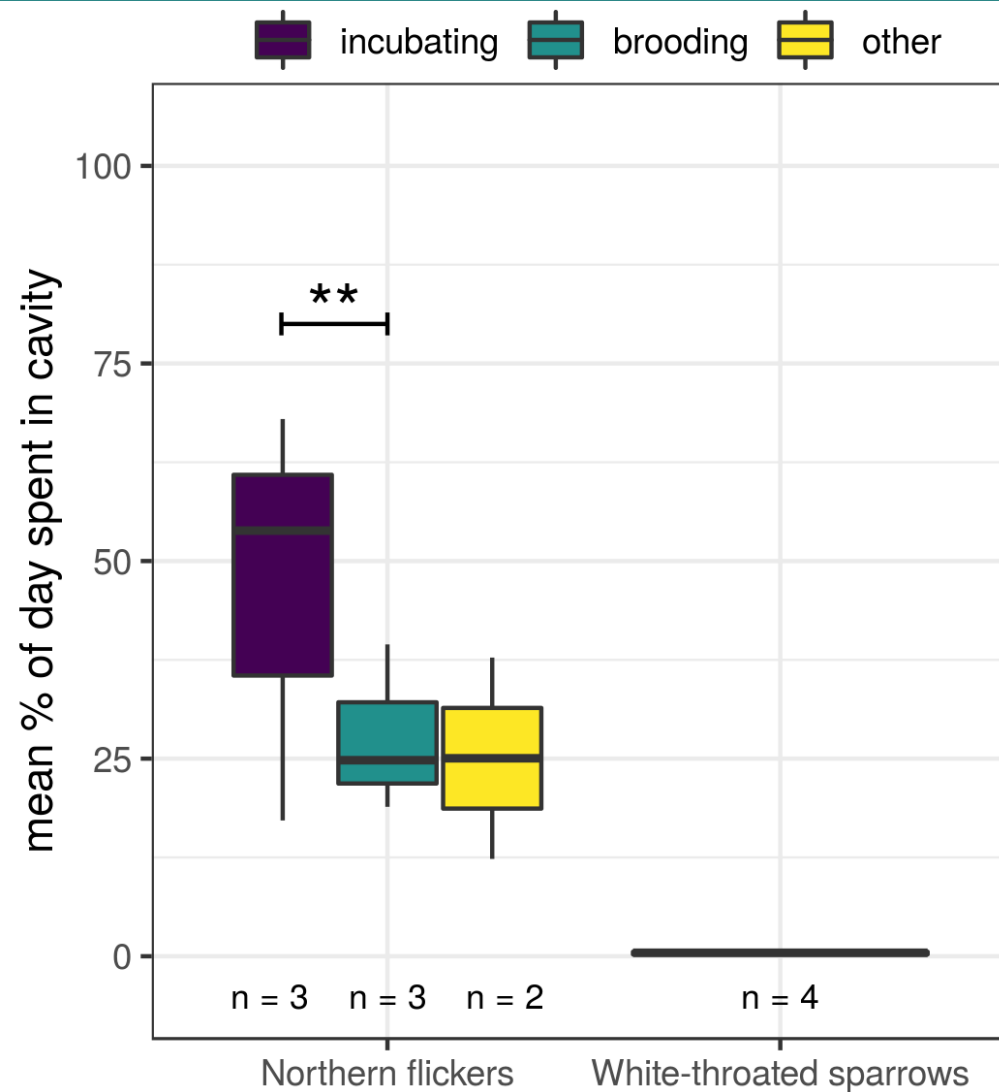


Daytime: Results

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b) Incubation cavity use

- Incubating flickers use cavities more than
 - Brooding flickers

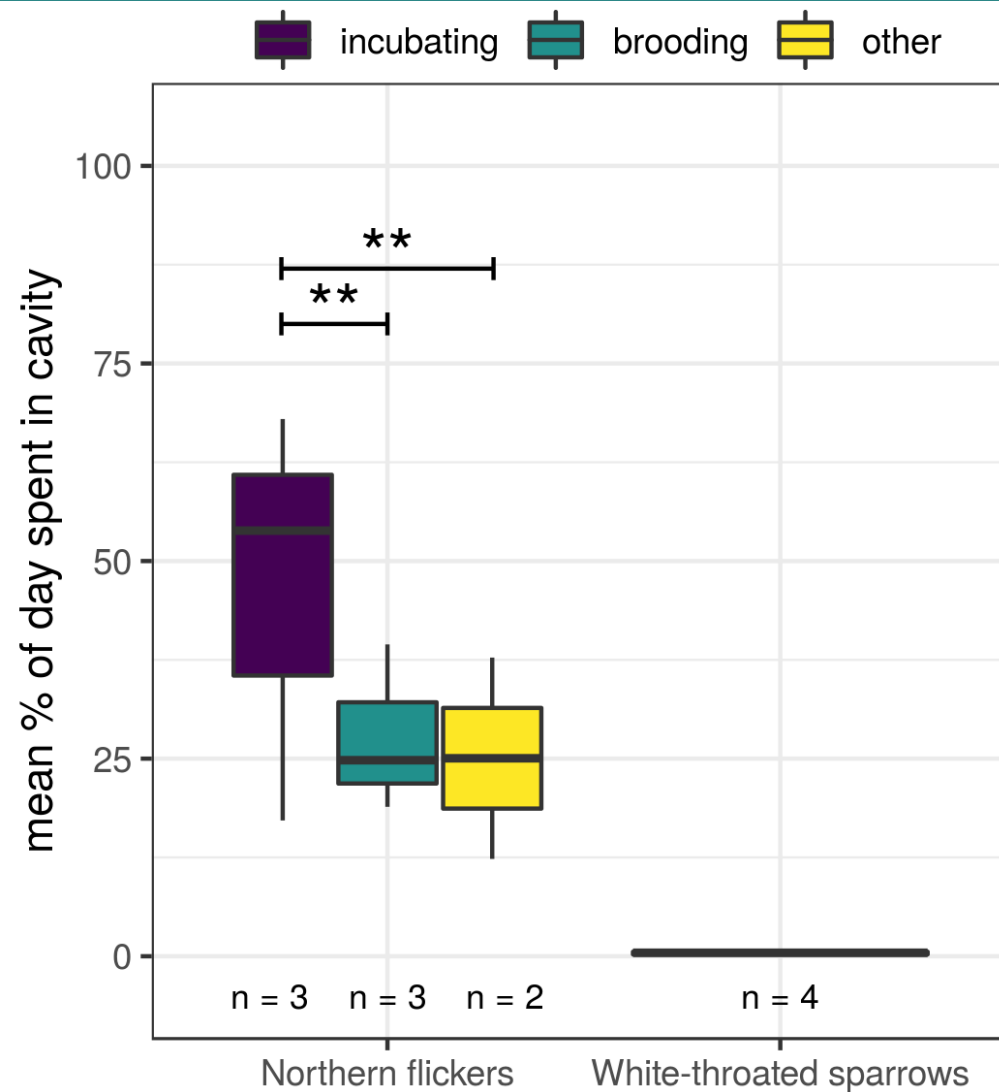


Daytime: Results

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b) Incubation cavity use

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

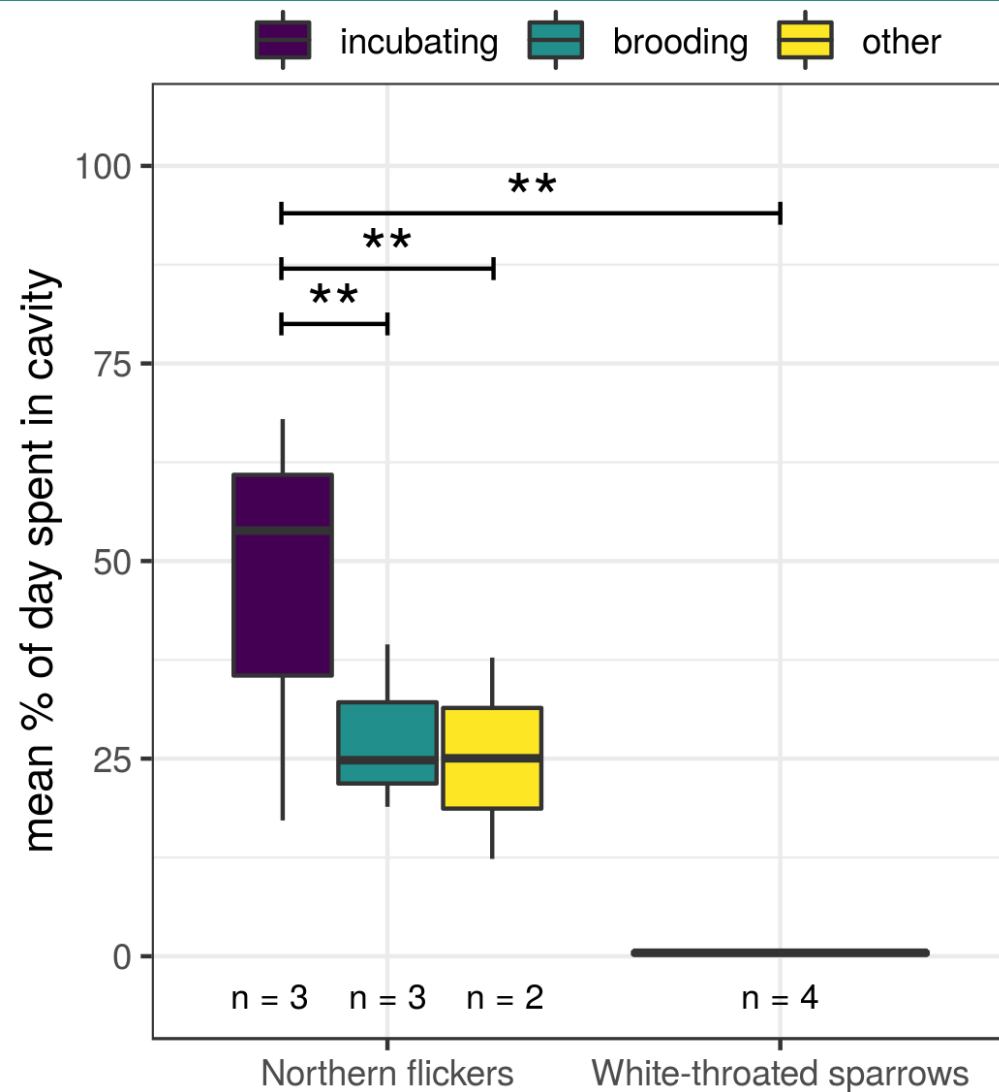


Daytime: Results

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b) Incubation cavity use

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

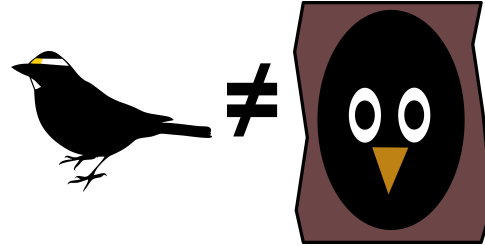


Nighttime: Hypotheses

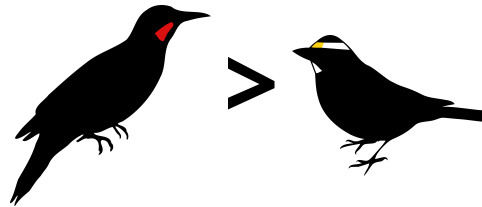
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a) Overall cavity use

Sparrows do not use cavities



Flickers use cavities more than Sparrows

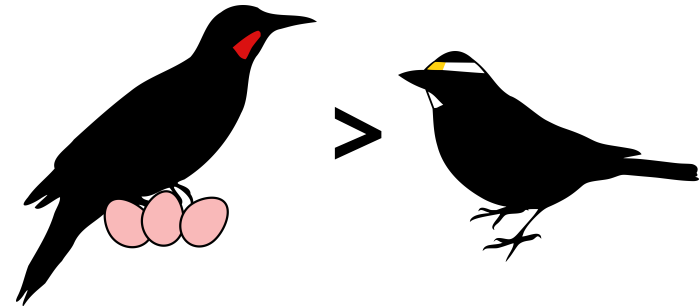
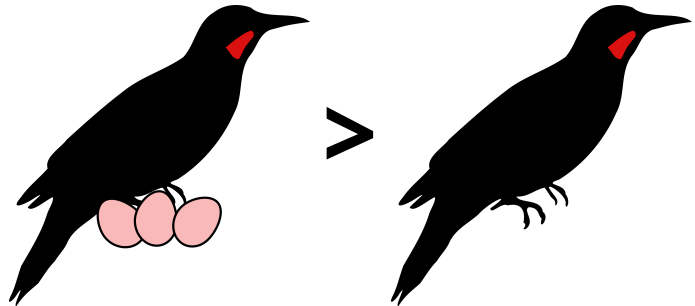


Nighttime: Hypotheses

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b) Incubation/Brooding cavity use

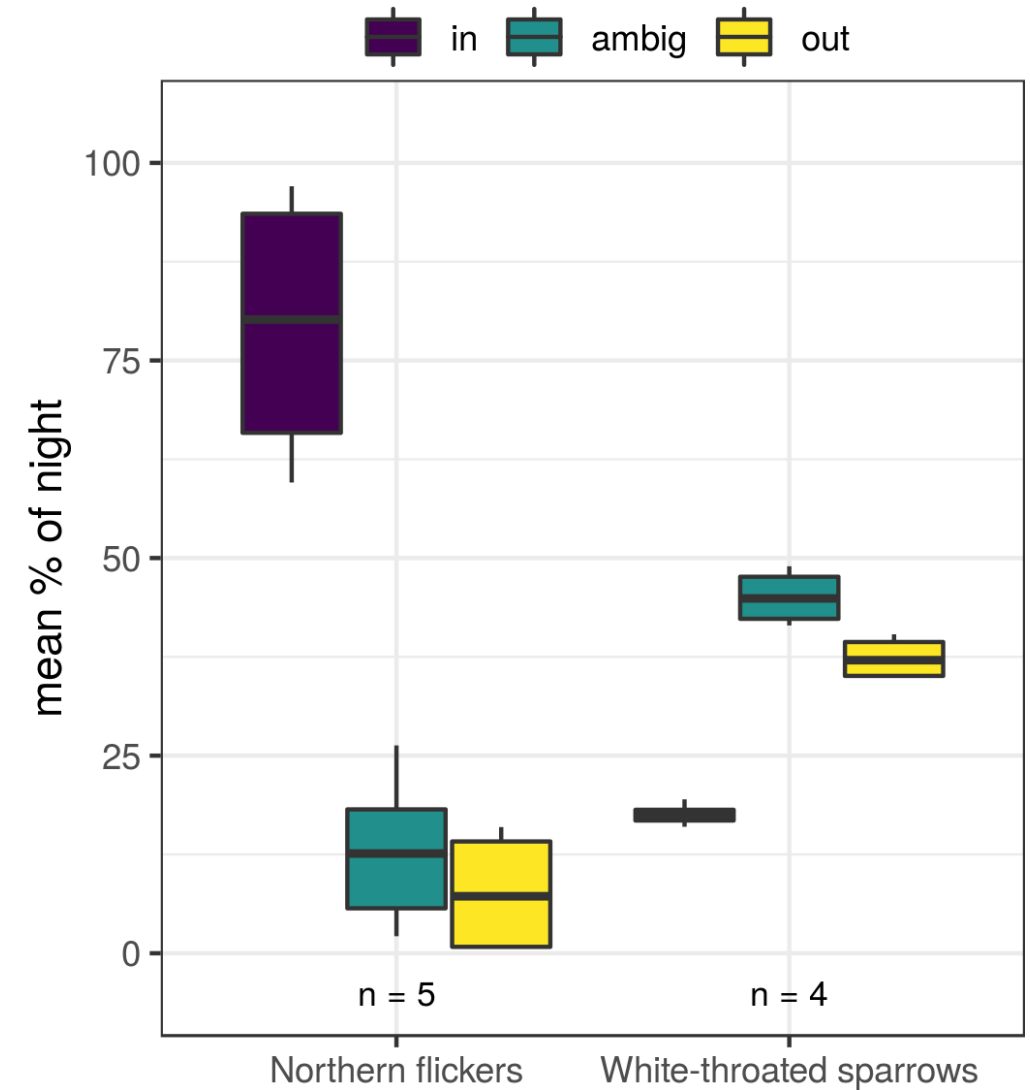
Incubating (with eggs) and Brooding (with nestlings) flickers use cavities more than Non-
Incubating/Brooding (Other) flickers & Sparrows



Nighttime: Results

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a) Overall cavity use

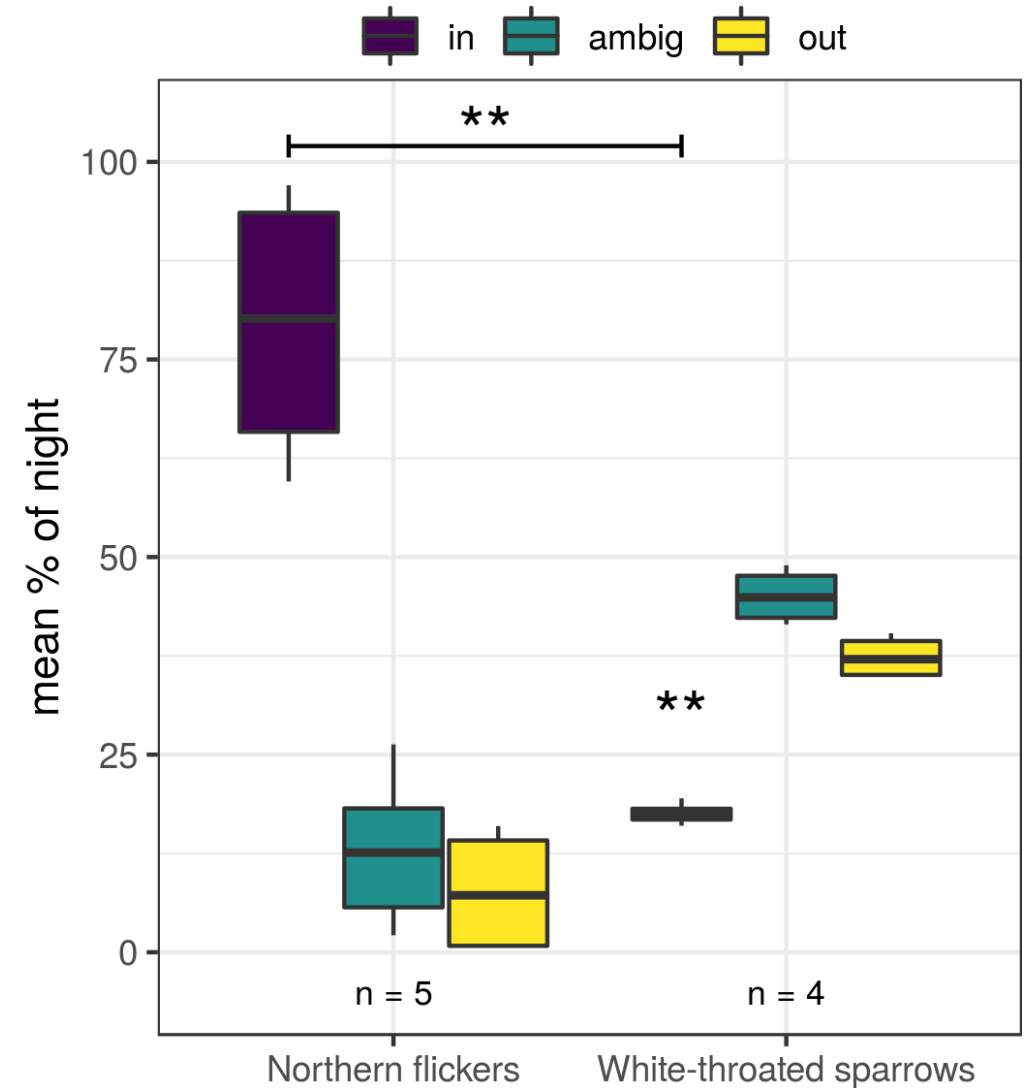


Nighttime: Results

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a) Overall cavity use

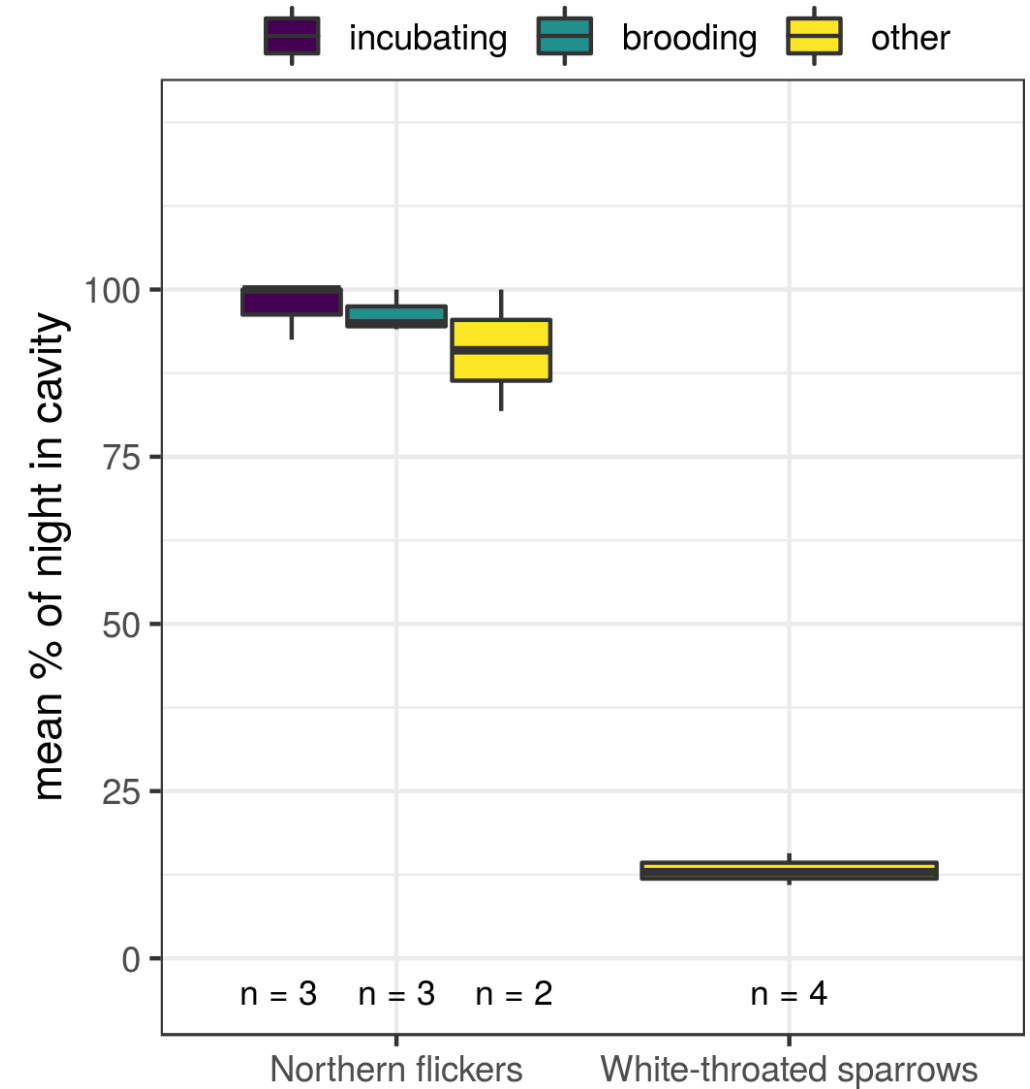
- Flickers use cavities more than Sparrows
- Sparrows **do** use cavities at night (?)



Nighttime: Results

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b) Incubation/Brooding cavity use



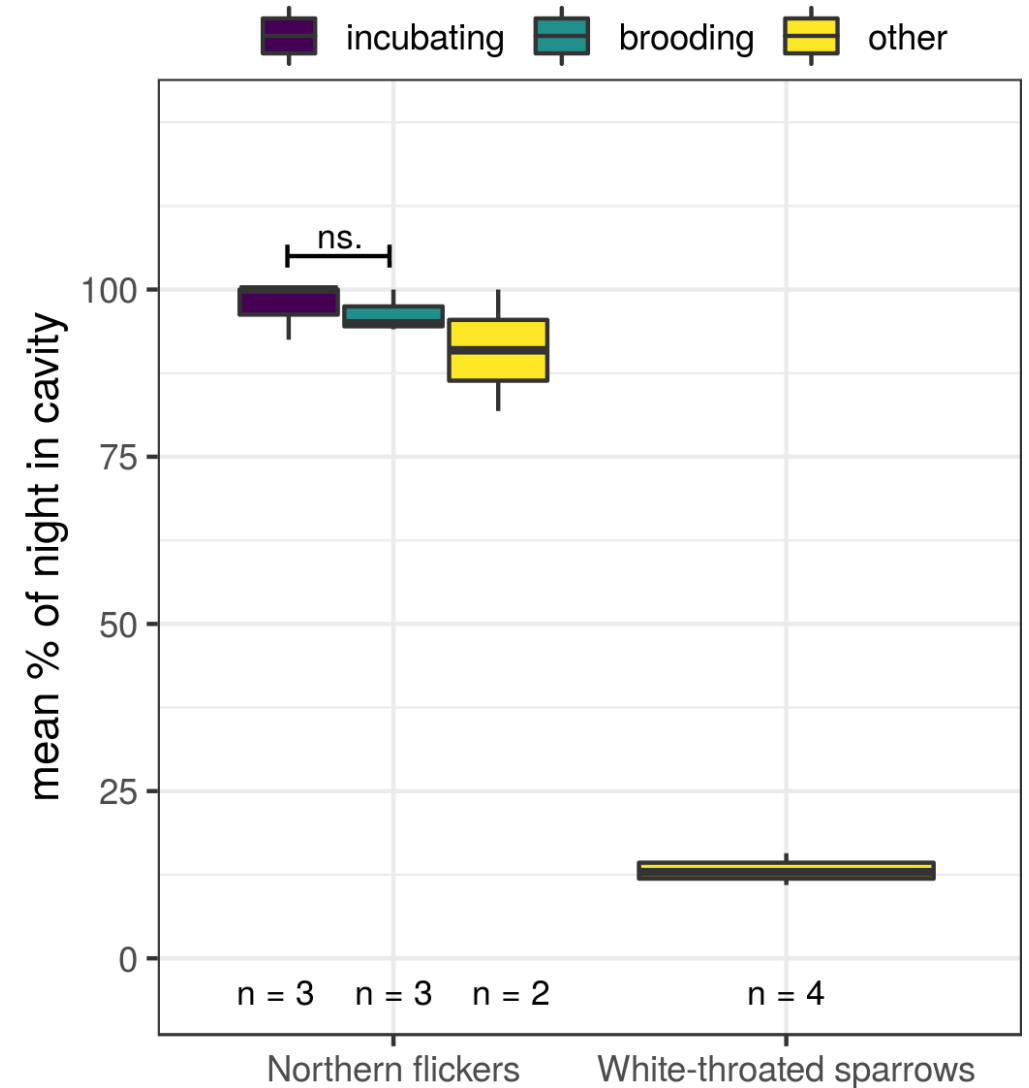
Nighttime: Results

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b) Incubation/Brooding cavity use

Incubating and Brooding flickers:

- Have similar cavity use



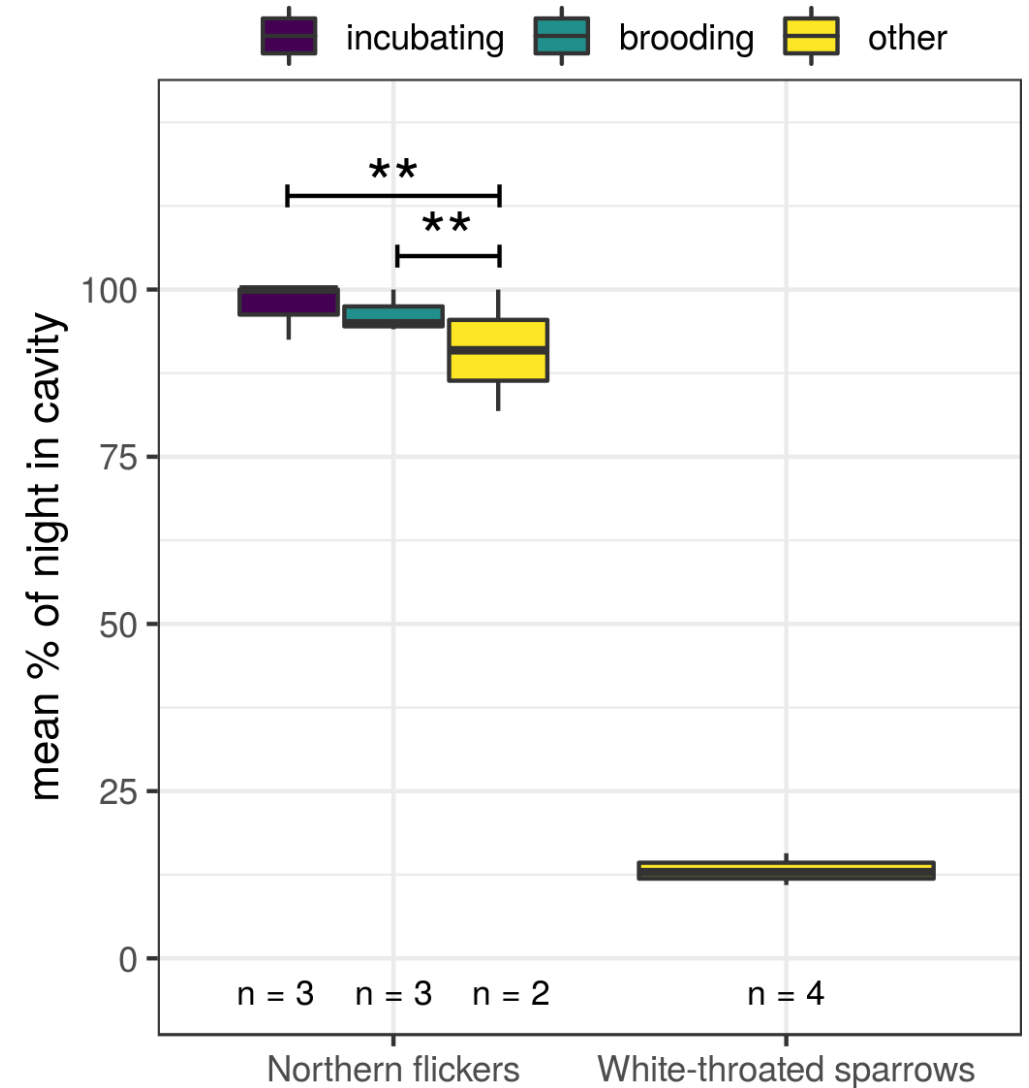
Nighttime: Results

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b) Incubation/Brooding cavity use

Incubating and Brooding flickers:

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



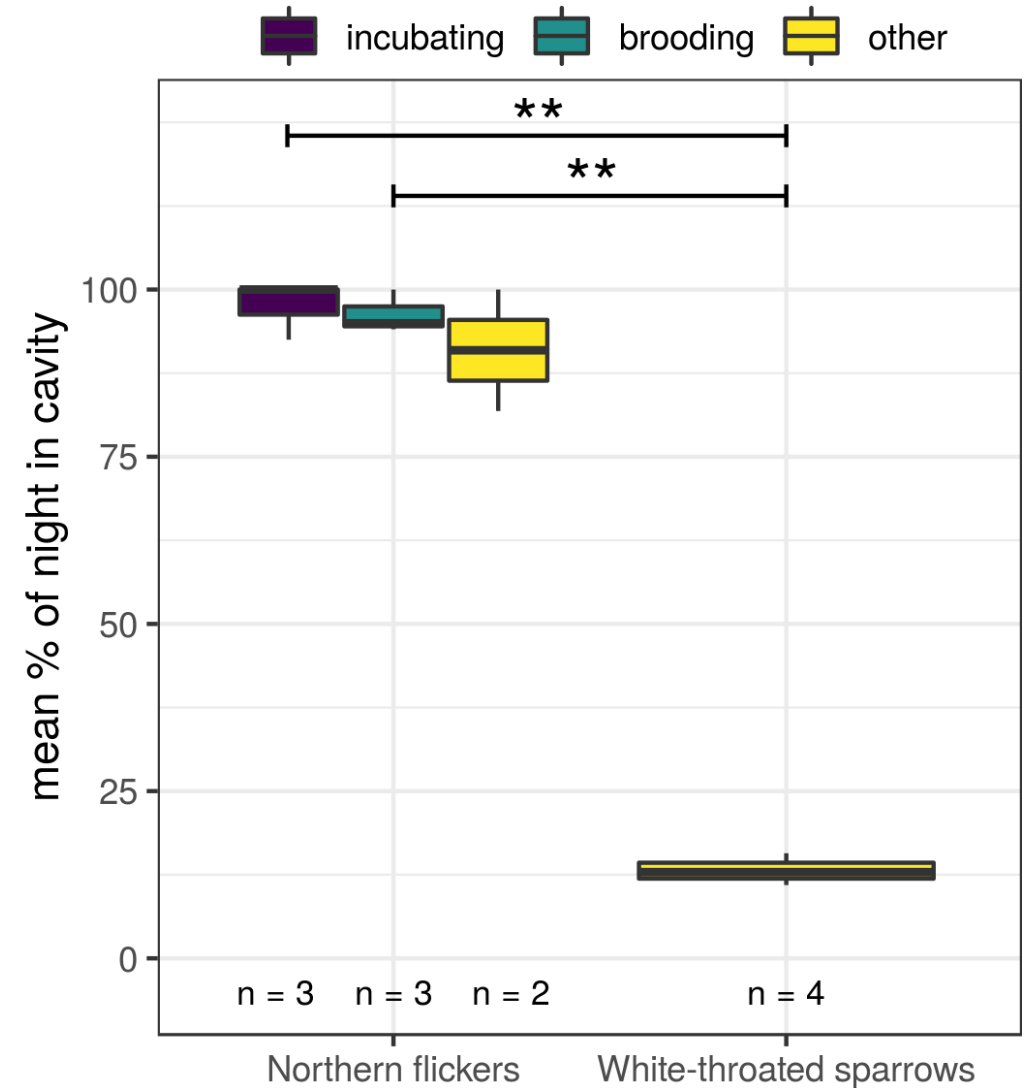
Nighttime: Results

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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

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Gow et al. 2015

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

cavityuse

- Scored by computer



IBIS

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

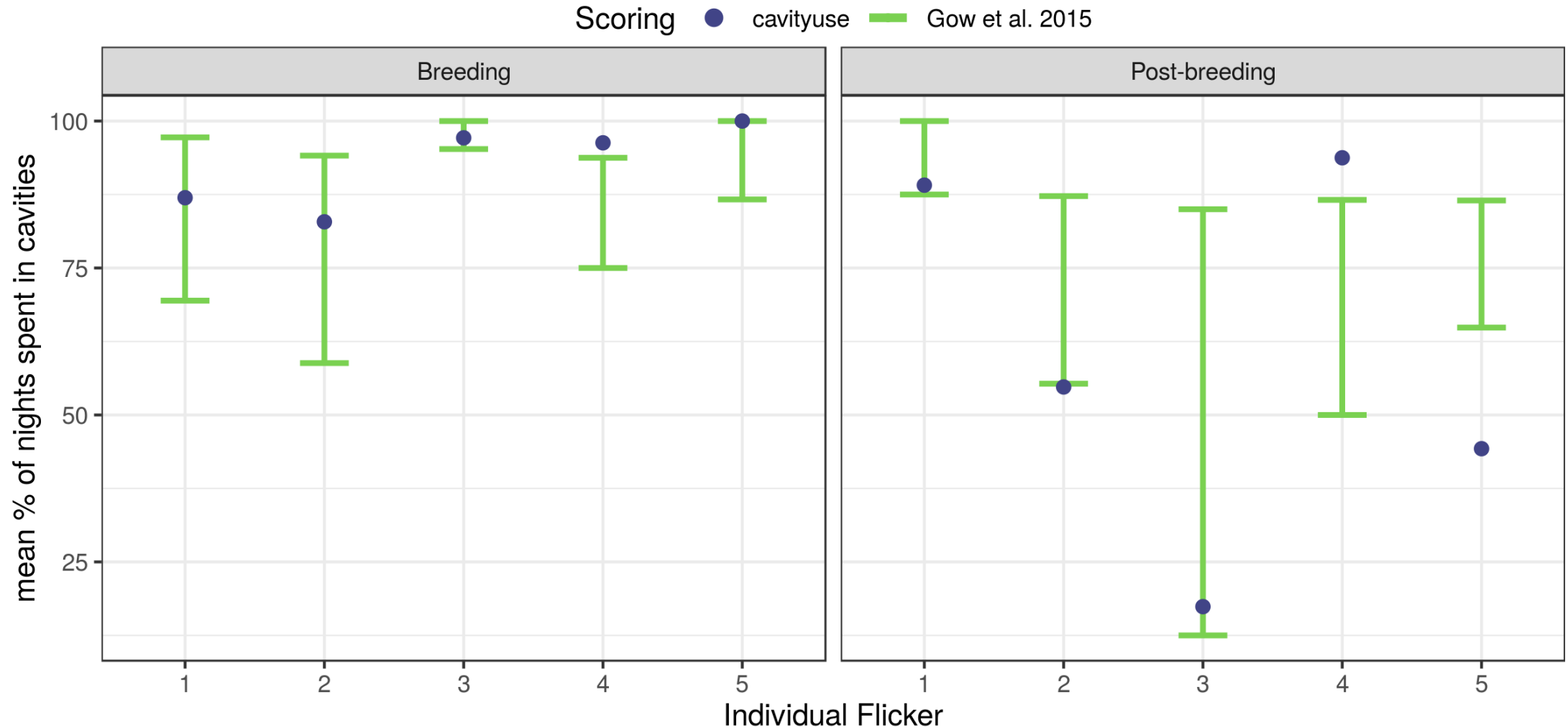
ELIZABETH A. GOW,^{1*} KAREN L. WIEBE¹ &
JAMES W. FOX^{2†}

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112 Science Place, Saskatoon, SK, S7N 5E2, Canada*

²*British Antarctic Survey, High Cross, Madingley Road,
Cambridge CB3 0ET, UK*

Comparing computers and humans

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cavityuse Conclusions

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Results match expectations:



cavityuse Conclusions

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- Overall daytime cavity use



cavityuse Conclusions

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Results match expectations:

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



cavityuse Conclusions

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Results match expectations:

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



cavityuse Conclusions

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- Computer- vs. Human-scored



cavityuse Conclusions

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Results match expectations:

- Overall daytime cavity use
- Relative daytime vs. nighttime cavity use
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 - Breeding cavity use
- Computer- vs. Human-scored

Results don't match expectations:

- Overall nighttime cavity use



Pwieland via Wikimedia Commons

cavityuse Conclusions

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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?

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- Improve nighttime detections
 - Detect more types of light transitions



H. Zell via Wikimedia Commons

What next?

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- 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?)



What next?

@steffilazerte

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



What next?

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

Ground truthing!



H. Zell via Wikimedia Commons

Check out cavityuse

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

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

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Thanks!



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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



References

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- 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

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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

Limitations

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

Daytime activity for white-throated sparrows

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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"

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Algorithm to detect sunrise/sunset

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

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Algorithm to detect sunrise/sunset

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Not bad!

