Assessing the potential impacts of radio transmitters on bat flight in a controlled environment

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Introduction

- Telemetry is an effective method for collecting movement and resource use data, however, attached transmitters have the potential to negatively impact the behavior and movement of wildlife, particularly volant species.
- Studies have suggested that such devices could even have additional implications on bat maneuverability and behavior (O'Mara et al. 2014; Aldridge and Brigham 1988).
- Despite these concerns, no peer-reviewed studies to date have assessed the potential effects of VHF radio-transmitters commonly used in bat telemetry surveys.
- Thus, we conducted a study on evening bats (*Nycticeius humeralis*) in a controlled environment (Fig. 1).
- We hypothesized that if a transponder affected bat maneuverability, we would observe a decrease in area usage, tortuosity, velocity, and flight duration.
- If the transmitter affected bat behavior, we would expect a reduction in total time spent active.
- And, we would expect an increase in sedentary activities, such as resting, roosting, and grooming.
- Furthermore, if bats habituated to the transmitter, we would expect such effects to diminish over time.

Figure 1: Image of Evening bat (*Nycticeius humeralis*)

Methods

- From March to August 2018, we housed wild-caught bats in a flight facility for 4 day intervals to record bat flight on Canon XA20 infrared camcorders with and without a radio transmitter attached.
- The flight facility is a stand-alone building with an internal meshed area divided into two equal sections (~8.5 x 5 m; Fig. 2).
- Preliminary surveys revealed that individual bats would not fly alone in the flight facility, thus, additional bats in the Colony side were used to trigger flight in the Trial side.

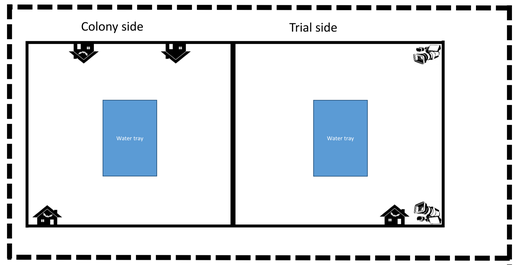


Figure 2: Layout of flight facility

Behavioral Trials

- Once bats were acclimatized, we conducted a control survey in which we recorded the 'natural' flight path of a bat for an entire hour (i.e., without a transmitter attached).
- We then conducted equivalent behavioral surveys on 3 consecutive nights with a transmitter attached.
- We attached a ~0.45 g SOM-2007-HWSC transmitter from Wildlife Materials (Murphysboro, IL) to a bat (Fig. 3).

Figure 3: Picture of transmitter attachment process

Video processing and analysis

- We used Noldus Ethovision software to track the bat and created a flight path (Figs. 4 and 5).

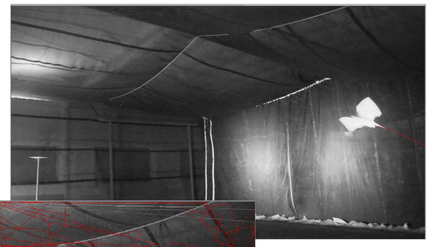


Figure 4: Example of Ethovision software tracking a bat

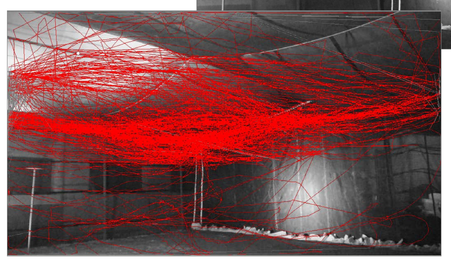
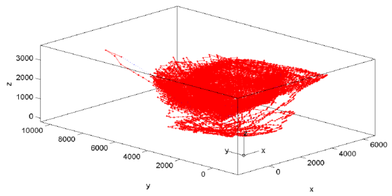


Figure 5: Example of completed flight path of a bat from 1 of 2 cameras

- We used Track 3D software to create a 3D flight path of the bat (Fig. 6).

Figure 6: Example of completed 3D flight path for one trial from which we extracted data on area usage, distance flown, speed & tortuosity



- Next, we determined the impact to behavior by using Studiocode software (Sydney, AU) to identify behaviors (Fig. 7).

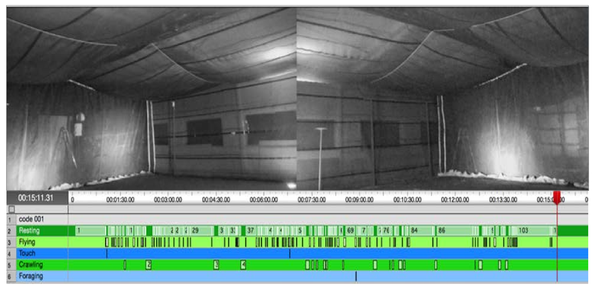
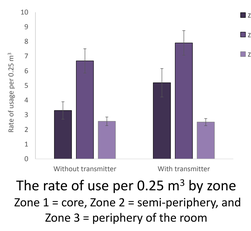


Figure 7: Example of the behavioral timeline for one trial from which we identified 6 distinct behaviors; flying, resting, crawling, landing, drinking, and foraging

Results

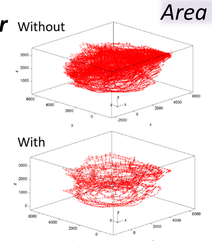
- We recorded 42 bats from 15 March – 28 August, 2018 and conducted a total of 150 behavioral surveys.
- To balance the analysis, we only included bats that successfully completed all 4 survey days (n = 30).

With and without the transmitter



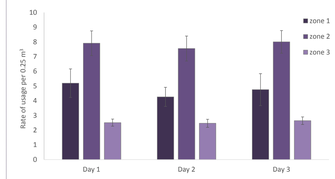
The rate of use per 0.25 m^3 by zone
Zone 1 = core, Zone 2 = semi-periphery, and Zone 3 = periphery of the room

Area Usage

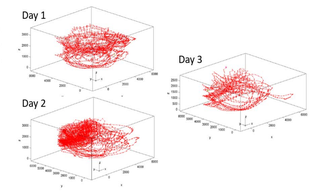


Visual representation of area usage

Effect of Transmitter Over time

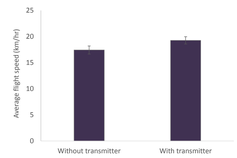


The rate of use per 0.25 m^3 by zone

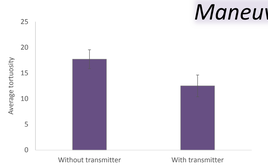


Visual representation of area usage

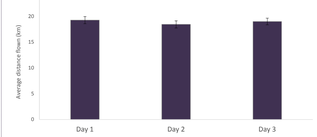
Maneuverability



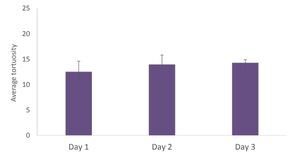
Speed (km/hr) of bat flight
* t=3.43, df=21, P=0.002



Tortuosity of bat flight
* U=1128, P=0.002

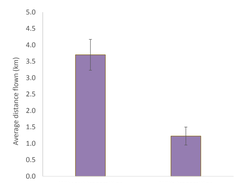


Speed (km/hr) of bat flight

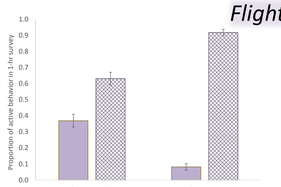


Tortuosity of bat flight

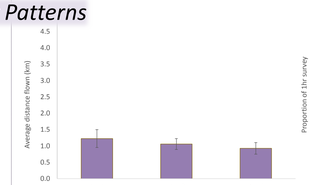
Flight Patterns



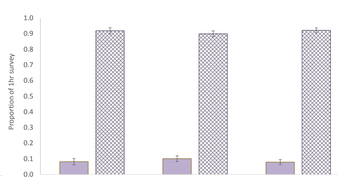
Distance flown by bats
* U=1242, P<0.001



Time bats spent flying (solid) and conducting non-flight behaviors (patterned)
* U=1105, P<0.001

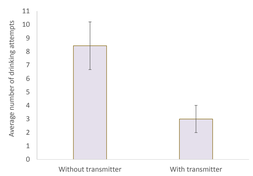


Distance flown by bats

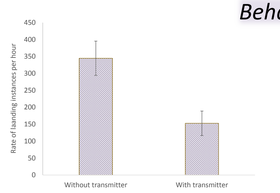


Time bats spent flying (solid) and conducting non-flight behaviors (patterned)

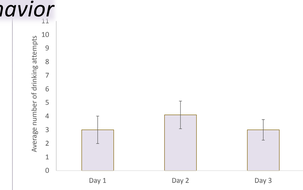
Behavior



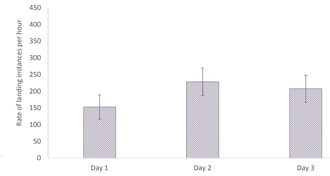
Drinking attempts
*U=962, P=0.006



Landing or touching instances
Bat stopped flying for <5 secs
* U=969, P=0.002



Drinking attempts



Landing or touching instances

Conclusions

- Our results demonstrate that attaching a transmitter **negatively impacted** area usage, maneuverability, flight patterns, and behavior of bats.
- Most notably, we observed a **78% reduction** of the proportion of time bats flew, **30% reduction** in turning abilities, and a **63% reduction** in the average number of drinking attempts.
- These impacts did not improve over time, suggesting that the bats are **not able to habituate** to the presence of the transmitter within the first three days of attachment.

- Such **transmitter effects** could therefore influence foraging success and drinking abilities, which in turn could **impact the fitness** of bats and ultimately their **survival**.
- Our study also **highlights a potential bias** in telemetry surveys that could impact data quality and collection.
- Subsequently, management strategies based on such research could potentially be **ineffective to implement**.
- Thus, we recommend that the transmitter effects we have identified should be taken into consideration when conducting telemetry surveys and interpreting the data.

Citations

Aldridge, H., and R. Brigham. 1988. Load carrying and maneuverability in an insectivorous bat - a test of the 5 percent rule of radio-telemetry. Journal of Mammalogy **69**: 379-382.

O'Mara, M. T., M. Wikelski, and D. K. N. Dechmann. 2014. 50 years of bat tracking: device attachment and future direction. Methods in Ecology and Evolution **5**:311-319.

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