Optimizing UAS for Bat Activity Monitoring near Wind Turbines: Investigating Deterrent and Habituation Effects

Drones4Bats

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1 Background

Fig. 1 Scenario of Usage: UAS during Transect Surveys

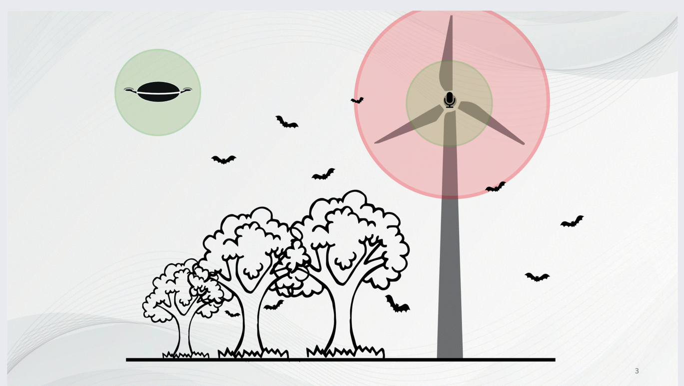

Fig. 2 Scenario of Usage: UAS during Nacelle Monitoring

- High bat fatalities at wind turbines
- Shutdown algotithem based on missing data
- Missing data in hard-to-reach regions

Idea: Using an unmanned arial system (UAS) eqipped with an acoustic bat detector

Our research questions for this study:
1. Does the flight of different UAS have a deterring or attracting effect on bats?
2. If such an effect exists, is there evidence of habituation over a 15-minute flight duration?

2 Material & Methods

Used UAS	Takeoff weight	Dimensions in cm (incl. Props)	Flight time	Wind resistance
	5.0 kg (incl. batteries)	143 x 143 x 53 Props: (43.1 x 16.5)	30 min	15 m/s
	150 g	260 x 240 x 80 Props: (18.8 x 10.2)	90 min	2 m/s

Tab. 1: Technical Data of the Used UAS. First Multicopter and Second Lighter Than Air (LTA) UAS

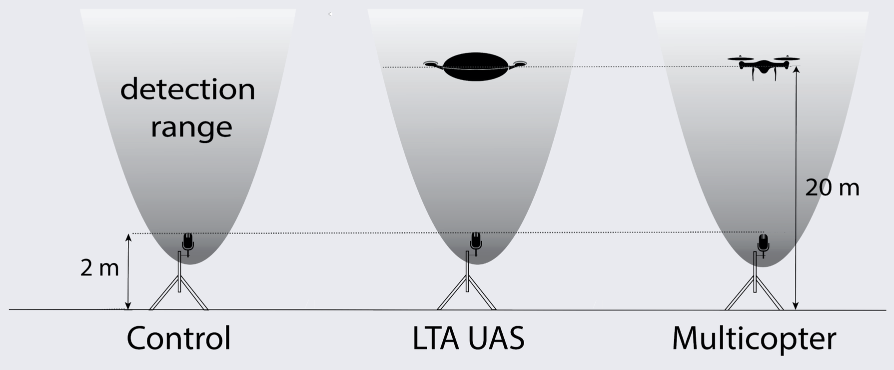

Fig. 3 Test Setup for Recording Data in Three Phases

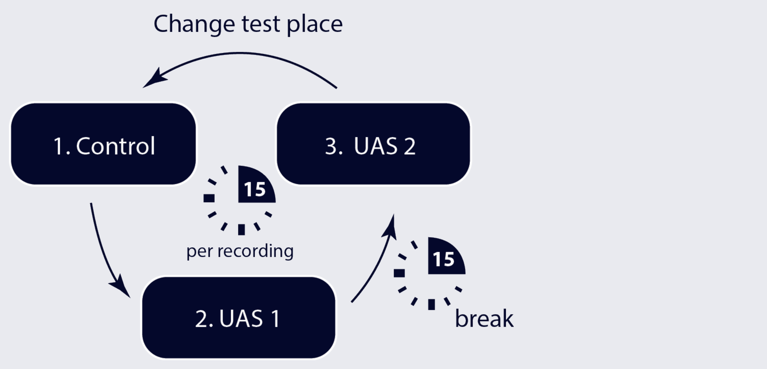

Fig. 4 Procedure of the Three Phases in Various Test Locations

3 Impact on Bat Activity

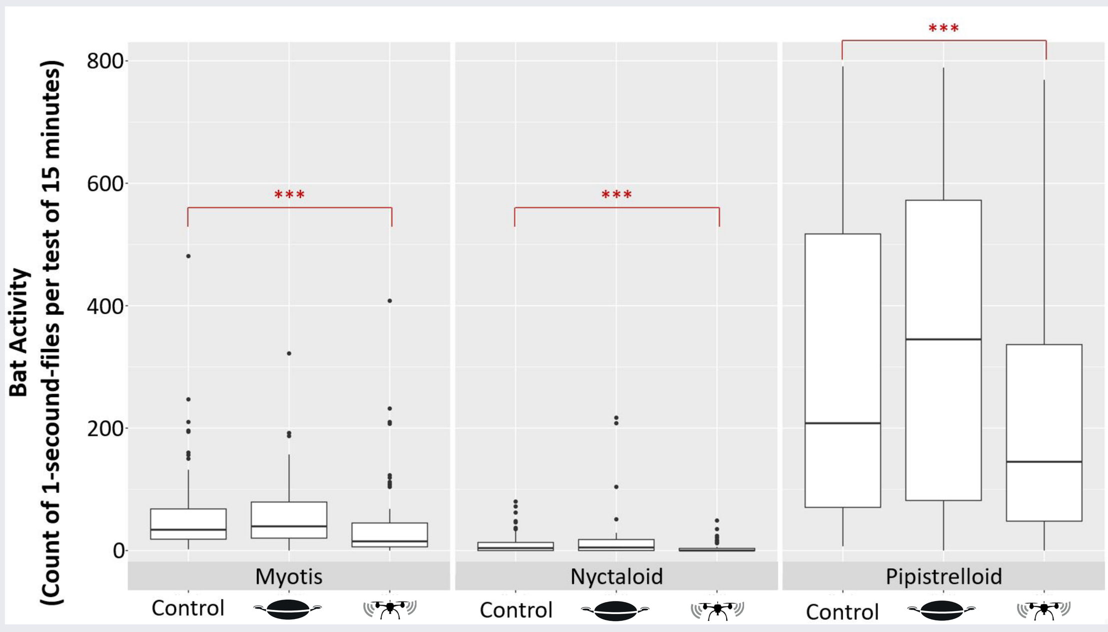

Fig. 5 Boxplots of Bat Activity for Each Test Setup (Control, LTA UAS, Multicopter) Across Bat Species (Pipistrelloid, Nyctaloid, Myotis)

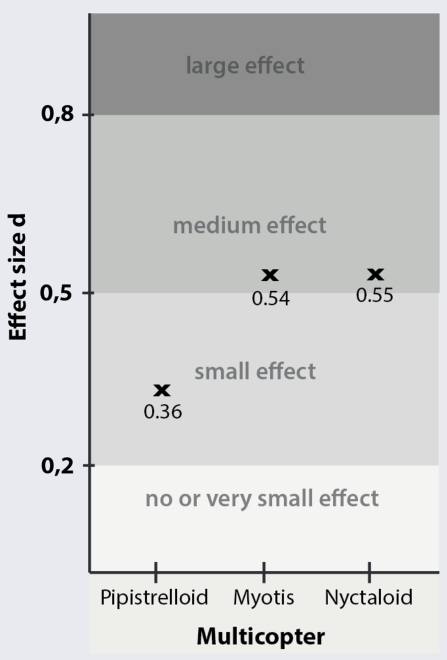

Fig. 6 Effect Size for Multicopter

- No significant difference in bat activity with LTA UAS flight compared to the control
- Highly significant bat activity difference with multicopter flight compared to the control
- Small effect size for the species Pipistrelloid
- Moderate effect size for the species Myotis and Nyctaloid

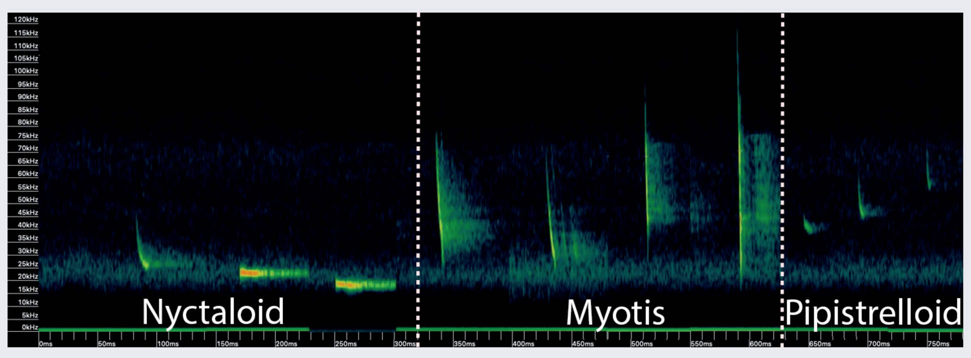

Fig. 7 Categorization of Bat Species Due to Echolocation Calls

4 Habituation Effect

- No significant changes during a 15-minute flight
- Estimated slope for changing bat activity per minute is < 0.1

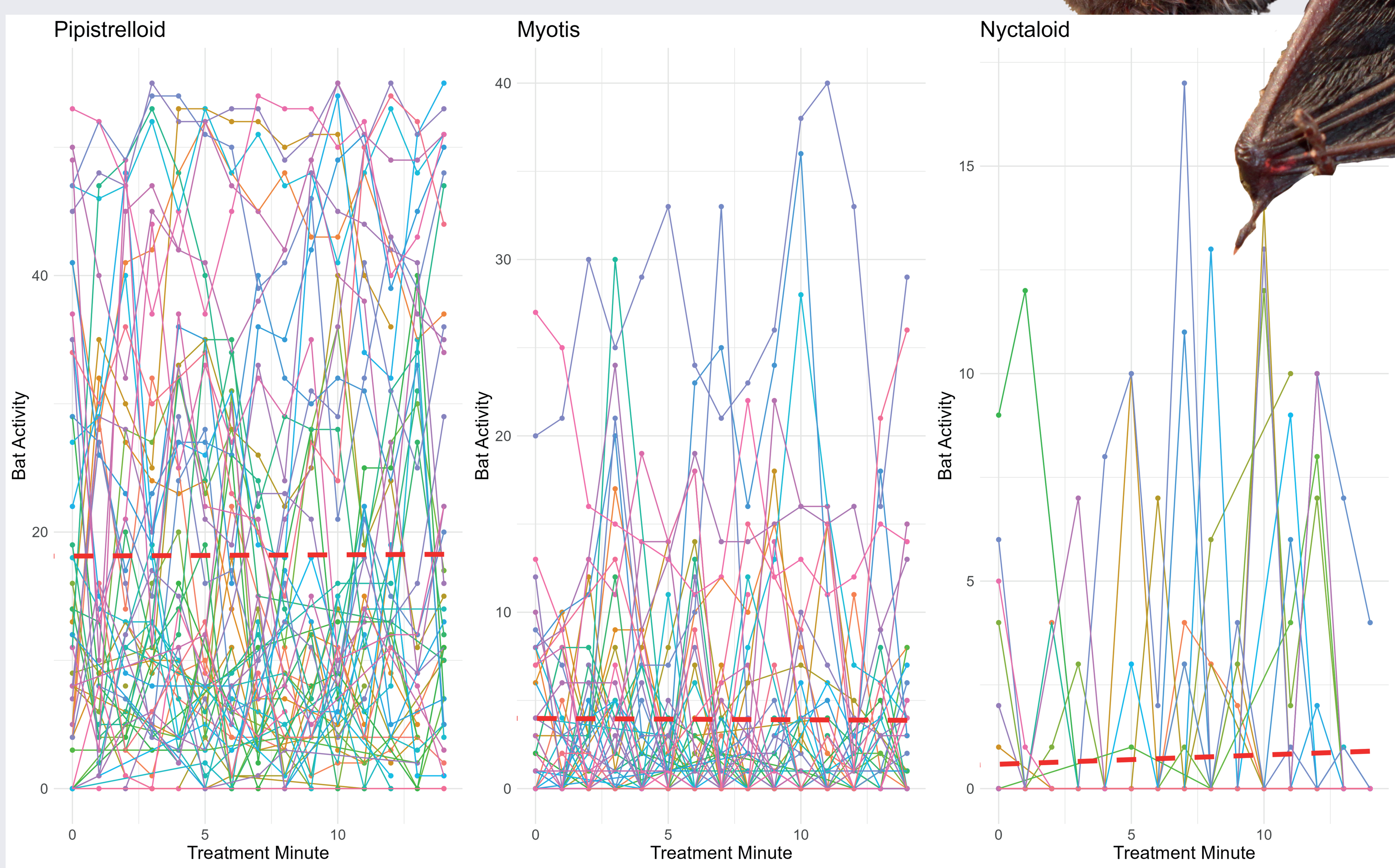

Fig. 8 Bat Activity per Treatment Minute: Connected Data Points per Day and Location. The Red Dashed Line Represents the Estimated Slope

5 Discussion

The highest bat activity was recorded during flights with the large and quiet LTA UAS with subdued ambient light. However, there was no statistically significant difference compared to the control, indicating that the LTA UAS neither deters nor attracts bats.
In contrast, the multicopter, which is notably larger and heavier compared to the multicopters used in other studies (Ednie et al., 2021; Kuhlmann et al., 2022), showed a statistically significant difference from the control, suggesting a deterrence effect.

Species-specific analyses showed that the deterrent effect was more pronounced for Nyctaloid and Myotis species compared to Pipistrellus. This higher effect size for Nyctaloid and Myotis species could be explained by the frequency of echolocation calls (compare figure 9-11). Some bat calls could be hidden in the noise of the multicopter, especially the Nyctaloid species. Therefore, recordings were manually identified.

Our study demonstrates that LTA UAS, due to their quiet flight, are suitable for acoustic bat monitoring without affecting the activity levels. However, it is essential to consider that this technology exhibited certain challenges in our studies concerning safe flight due to its notable susceptibility to winds.

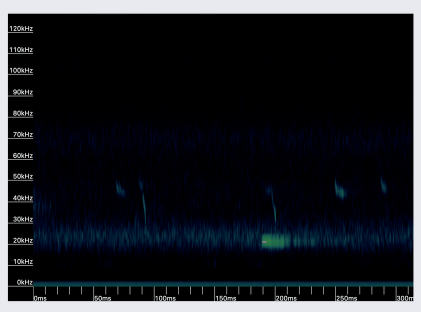

Figure 9: Sonagram of control

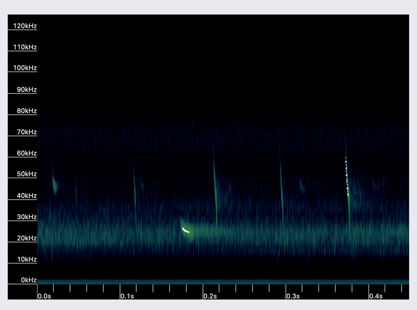

Figure 10: Sonagram of LTA UAS

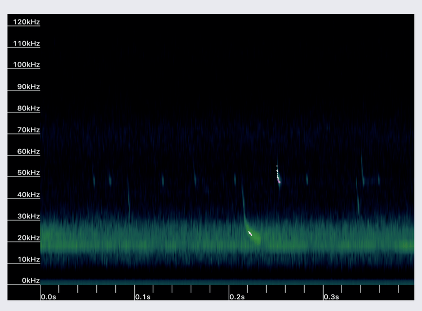

Figure 11: Sonagram of multicopter

6 Conclusion

Our study has presented two different types of UAS capable of recording bat activity in real-world environments, each showing varying effects on the identified bat activity. Through our research, we have laid essential foundations for the monitoring of bats using UAS. This includes the utilization of LTA UAS, which should address susceptibility to wind through more robust propeller mechanisms.

Additionally, our findings underscore that the employment of a larger and heavier drone, as opposed to conventionally tested counterparts, only minimally or moderately (depending on bat species) impacts activity levels. Furthermore, we have demonstrated that bat activity does not acclimate to the presence of the drone during a 15-minute flight.

Additionally, it is pertinent to note that our findings diverge from Kuhlmann's (2022) comparable study, which proposed the suitability of smaller UAS over larger UAS. Our research, however, suggests that while lighter UAS instead of smaller hold promise, they must demonstrate the capacity to navigate practical conditions, including potential wind challenges and supplementary equipment loads.

Refereences

Ednie, G., Bird, D.M. & Elliott, K.H. (2021). Fewer bat passes are detected during small, commercial drone flights. Scientific reports 11 (1): 11529

Kuhlmann, K., Fontaine, A., Brisson-Curadeau, É., Bird, D.M. & Elliott, K.H. (2022). Miniaturization eliminates detectable impacts of drones on bat activity. Methods Ecol Evol 13 (4): 842–851

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