

ALEXANDRA HOWARD

RESEARCH PROJECT: Diversity and ecosystem services of insectivorous bats in deciduous fruits farms of the eastern Free State Province, South Africa.

The role of bats in agriculture is understudied and relatively unknown in the Free State Province, which is a vitally important agricultural region of South Africa. Additionally, there is a growing movement to reduce the reliance on pesticides within the South African deciduous fruit sector as export countries - such as the European Union - ban further pesticide chemicals, thus affecting our export market economy. By generating the baseline acoustic data, DNA sampling of bats and insect pests and the conceptual framework required, this research aims to estimate the value of bats as natural capital in terms of their pest control services on apple farms. This project will enable recommendations to be employed by all stakeholders to ensure sustainable farming management practices and biodiversity conservation strategies.

Background and Rationale

This PhD project aims to determine the contributions of bat pest suppression services to the deciduous fruit industry and wider agricultural landscape by local bat species in an understudied montane region of central South Africa. Natural pest control services provided by bats have been demonstrated in a few crops in the Global North (Charbonnier et al. 2021; Kolkert et al. 2020; Montauban et al. 2020). However, the trophic link between bats and deciduous fruit crop pests remains largely unknown in South Africa. This study plans to expand on the seminal work by Taylor et al. (2018), based on macadamia crops — with the aim for this model to be potentially applied in many agroecosystems across southern Africa. Despite the intensive biocontrol and integrated pest management efforts, the role of bats as a bio-control agent has not been adequately investigated, even though many serious economic pests are known to be predated upon by insectivorous bats (Kolkert et al. 2020). As agriculture is considered one of the main drivers reducing roost availability, foraging habitat and food availability for bats, we hope this project will enable recommendations to be employed by all stakeholders to ensure sustainable farming management practices and improved biodiversity conservation strategies (Park 2015). Furthermore, this project has the potential to align directly and indirectly with at least five of the UN Sustainable Goals for 2030

including Zero Hunger; Industry Innovation & Infrastructure; Responsible Consumption & Production; Climate Action as well as Life on Land (United Nations, 2015). This project addresses the lack of bat and ecosystem service research across Africa (Wangai et al. 2016), as we strive to demonstrate the economic value of bats to counteract the persecution and misplaced public fears emphasized by COVID-19.

Objectives and methodology

Using bat diet and activity patterns, as well as indices of pest damage and apple yield, the main aim of this research is to quantify the economic and ecological roles of bats in apple orchards and surrounding natural landscapes, thereby demonstrating this vital service to local communities. Techniques such as molecular diet analysis by metabarcoding, acoustic and capture surveys of bats, economic yield calculations by avoided cost modelling, and standardised questionnaires to assess public perceptions are being used in the eastern Free State for the first time (Taylor et al. 2018; Weier et al. 2019a; Perez et al. 2021).

Timeline

2021 - ethics and permit approvals, landowner engagement and surveys

2022 - acoustic fieldwork, bat box construction and implementation

2023 - acoustic analysis, molecular lab work optimisation

2024 - metabarcoding lab work for diet analysis, environmental landscape analysis, economic estimates by avoided-cost model

2025 - write up and submit PhD with publications

Results and preliminary data

Preliminary results from the acoustic monitoring have confirmed the presence of at least 11 species of insectivorous bats while foraging activity has been recorded at all the study sites surveyed in 2021 to 2023. At all but one site, the spring season exhibited higher bat species richness and activity than summer. Bat activity was much lower in winter, but two species were still recorded in the orchards. The Cape Serotine, *Laephotis capensis*, is the most abundant species recorded and encountered at each site. All bat boxes erected were occupied within 8 weeks to 8 months by this species. Results from a pilot laboratory test of bat faecal

pellets indicated pesticide residues from a toxic fungicide and insecticide with known health and environmental hazards. Molecular analysis of the bats' diet will help ascertain the quantity and type of insect pests consumed throughout the growing season of the apple orchards as well as in the surrounding landscape of human settlements. Furthermore, this project has contributed new distributional records, genetic data and echolocation call libraries through assessment of the bat species assemblage of the eastern Free State study area in South Africa.

References

- Charbonnier et al. 2021. Pest control services provided by bats in vineyard landscapes. *Agriculture, Ecosystems & Environment*, 306: 107207.
- Kolkert et al. 2020. Insectivorous bats selectively source moths and eat mostly pest insects on dryland and irrigated cotton farms. *Ecology and Evolution*, 10(1): 371-388.
- Montauban et al. 2020. Bats as natural samplers: First record of the invasive pest rice water weevil *Lissorhoptrus oryzophilus* in the Iberian Peninsula. *Crop Protection*, 141: 105427.
- Park, K.J. 2015. Mitigating the impacts of agriculture on biodiversity: bats and their potential role as bio indicators. *Mammalian Biology*, 80(3): 191-204.
- Perez et al. 2021. Design and Psychometric Properties of the BAAtSS: A New Tool to Assess Attitudes towards Bats. *Animals*, 11(2): 244.
- Taylor et al. 2018. Economic value of bat predation services - a review and estimates from macadamia orchards. *Ecosystem Services* 30: 372-381.
- United Nations. 2015. Transforming Our World The 2030 Agenda for Sustainable Development. Resolution Adopted by the General Assembly on 25 September 2015, 42809, 1-13.
- Weier et al. 2019. Insect pest consumption by bats in macadamia orchards established by molecular diet analyses. *Global Ecology and Conservation*, 18, e00626.
- Wangai et al. 2016. A review of studies on ecosystem services in Africa. *International journal of sustainable built environment*, 5(2): 225-245.