BU MATCH FUNDED STUDENTSHIPS 2024 PROJECT DESCRIPTION

PROJECT TITLE

Predators and lowland wading birds: from models to management

PROJECT SUMMARY

Aim:

This project will give conservation organisations knowledge and tools to conserve key endangered bird species by creating the first multispecies bird-predator model to predict predation impacts and the effectiveness of alternative management regimes to minimise these impacts. Such species are currently threatened by high predation pressure and require urgent evidence-informed conservation action.

Rationale:

Many bird species which use lowland landscapes, such as Eurasian Curlew (*Numenius arquata*) and Black-tailed Godwit (*Limosa limosa*), are experiencing significant population declines; for example, Curlew numbers in the UK declined by 48% between 1995 and 2020[1]. Indeed, the scale of the decline in Curlew numbers has led to conservationists arguing that it should now be considered "*the UK's highest conservation priority bird species*", requiring urgent conservation action to prevent the extinction of this iconic species[2]. These ground-nesting birds face high levels of predation from mid-trophic level predators (termed 'mesopredators') such as Red Fox (*Vulpes vulpes*) and Carrion Crow (*Corvus corone*), which limits their ability to raise sufficient young to allow viable populations of these birds[3]. The efforts of conservation organisations to saving these species will be ineffective unless there is a marked improvement in (i) available knowledge of the drivers and impacts of predation, and (ii) the ability to test solutions to address the impacts of predation.

Methods:

This project will develop and test an individual-based model (IBM) of ground-nesting wading birds and their mammalian and avian mesopredators. IBMs are spatially- and temporally-explicit simulations of the interactions between individuals and their environment, that mimic the ways in which real animals behave[4]. Developing IBMs can be a valuable means of refining our understanding of a particular ecosystem and can act as '*in silico*' virtual laboratories to predict the effects of interventions (such as changes in management). As such, IBMs have proven to be powerful decision-support tools to inform nature conservation[5].

IBMs offer a means to test potential management options for reducing the impacts of predation on ground-nesting birds. Examples of such management options include the exclusion or control of one or more predator species, and releases of captive-bred birds to boost population sizes. Using an IBM to predict the efficacy of management solutions allows researchers to assess which solutions show sufficiently strong results to warrant further exploration, without the need to undertake costly and logistically-challenging field trials of all possible management options.

Whilst models of avian and mammalian species have been developed previously[6,7], to date there have been no attempts to develop a multispecies model of ground-nesting birds and the multiple species of predators. The IBM developed in this PhD will therefore be a novel decision-support tool that will be used to help conservation organisations to understand the drivers and impacts of predation, and to predict the outcomes of different management solutions. The multi-species model will be developed for the Severn and Avon Vales (southwest UK). This system has been selected as the match-funder is currently undertaking extensive collection of data that can be used in this project (including nest locations, breeding success, and predation rates), and also has strong connections with key local stakeholders including landowners/managers that will benefit the proposed PhD. The model will be developed and tested based on field data from the Severn and Avon Vales and comparable systems, state-of-the-art data synthesis techniques (including systematic review and meta-analysis), and model calibration.

The model will be developed using data already available from the Wildfowl and Wetlands Trust (WWT) which will include the abundance of mesopredators (Red Fox, European Badger *Meles meles*, stoat *Mustela erminea*, Carrion Crow, Jackdaw *Coloeus monedula*, Common Raven *Corvus corax*, Eurasian Magpie *Pica pica*, Red Kite *Milvus milvus* and Common Buzzard *Buteo buteo*) within the study area. In addition to the camera trap and eDNA data on abundance and predation

rates collected by WWT, additional data on avian predator abundances are available from the annual Breeding Birds Survey (which WWT have access to). WWT has also collected data on Curlew nest locations, movements, and breeding success through nest monitoring and GPS tagging. WWT began data collection in 2019 and will continue at least until 2025. The likelihood of these species encountering wading birds and the relative benefits for these predators of consuming wading bird eggs or chicks in comparison to other prey will then be generated. The model will use these data to predict the frequency with which wading bird eggs or chicks would be likely to be consumed by these predators. The model will be tested by comparing the rate at which eggs or chicks are predicted to be predated by different predator species with observed rates of predation. Any differences between predictions and observations will be used to inform model calibration, for example to adjust the efficiency with which predators locate their prey to reduce the difference between observed and predicted rates of predation. The model will then be used to predict the relative benefits of alternative management regimes, for example predator control to reduce predator numbers, to reduce the impacts on wading birds.

The project will use the predictions of the IBM to address the following key questions:

- What are the impacts of different predator species on the nesting success of the threatened ground-nesting birds such as the Eurasian Curlew?
- What are the contributions of key food resources (including ground-nesting birds, released game birds, and roadkill/carrion) to the diets of predators?
- What are the spatial and temporal patterns of predation pressure in the landscape?
- How effective will different management measures (such as predator control, stopping gamebird releases, or removal of roadkill) be on reducing predation of ground-nesting birds?
- What is the sensitivity of the model predictions to changes in the parameter values?

References:

[1]Harris, S.J., et al. (2022). The breeding bird survey 2021. BTO research report.

[2]Brown, D., et al. (2015). The Eurasian Curlew–the most pressing bird conservation priority in the UK. British Birds, 108, 660-668.

[3]Viana, D.S., et al. (2023). A synthesis of Eurasian Curlew (Numenius arquata arquata) demography and population viability to inform its management. Ibis, 165, 767-780.

[4]Stillman, R.A., et al. (2015). Making predictions in a changing world: the benefits of individual-based ecology. BioScience, 65, 140-150.

[5]Wood, K.A., et al. (2015). Co-creation of individual-based models by practitioners and modellers to inform environmental decision-making. Journal of Applied Ecology, 85, 810–815.

[6]Stillman, R.A. & Goss-Custard, J.D. (2010). Individual-based ecology of coastal birds. Biological Reviews, 85, 413-434.

[7]Hradsky, B.A., et al. (2019). FoxNet: An individual-based model framework to support management of an invasive predator, the red fox. Journal of Applied Ecology, 56, 1460-1470.

ACADEMIC IMPACT

The PhD intersects the fields of behavioural ecology, food web ecology, and conservation biology, and will offer advances in each of these fields. The results of the modelling work will provide new insights into the competitive interactions between multiple predator species, and how variations in the abundance of one predator may modulate the impacts of other predators on shared prey resources. The work undertaken as part of this PhD will improve our understanding of multi-species interactions within complex food webs, between breeding birds and their predators. Specifically, this PhD will address the key question of whether the impacts of predators on nesting birds are additive or compensatory.

Furthermore, the model developed in the PhD will advance our ability to simulate interactions between ground-nesting birds and multiple predator species, as to date multi-species individual-based model spanning multiple trophic levels are rare and most IBMs remain focused on single species.

Given the novelty of this work, and its capacity to have substantial academic impact through addressing key questions of broad relevance to the research community, we expect that chapters will be publishable in high-quality, international scientific journals. The project will also be presented at international conferences. The supervisory team will fully support the student to maximise the opportunities to produce such high-quality outputs from the project.

SOCIETAL IMPACT
The project will support the efforts of conservation organisations to restore viable populations of the iconic species that live in lowland ecosystems, such as Eurasian Curlews (currently classified as Red in Birds of Conservation Concern 4: The Red List for Birds (2015) and a priority species under the UK Post-2010 Biodiversity Framework) and therefore will be of considerable interest for conservation practitioners, land managers and decision-makers. Such species are currently threatened by extinction through predation in the UK, which is hindering efforts to restore viable breeding populations of these species. Conservation organisations will not be able to save these species unless we gain the improved understanding of predation and how to tackle it, that this novel project will provide. Restoring viable populations of lowland wading birds such as Curlew will not only benefit biodiversity, but also the provision of ecosystem services for people as higher numbers of lowland wading birds will facilitate greater opportunities for bird watching. This project will also have an economic impact as the managing predators such as red fox or badger can very expensive and therefore will have the potential to influence policy management. This project, through its aims to enhance biodiversity in the UK will also raise the interest of the general public, and the student will be encouraged to disseminate their findings more widely, for example, by giving public lectures.
PGR DEVELOPMENT OPPORTUNITIES
You will gain competencies in a range of quantitative skills, including computer modelling, data synthesis, and statistical analyses. These skills will be developed through a combination of external training courses, 1:1 tuition from the supervisory team, and self-directed learning. Through the studentship, you will also gain important transferable skills in written and oral communication. You will have opportunities to develop your skills in communicating your work to a wide range of audiences through writing their thesis, scientific publications, and popular articles aimed at non-technical audiences. In addition, there will be opportunities to present your work to scientists, practitioners, and the public, which will give you the ability to advance your skills in science communication. You will also benefit highly from the current PhD community within the Department of Life and Environmental Sciences (LES), of which 3 PhD students are working on related study systems, including Curlew nesting success and fox distribution within the New Forest. You will also gain key transferable skills in time management, project management, and problem-solving.

SUPERVISORY TEAM	
Lead Supervisor	Professor Richard Stillman (Bournemouth University)
Additional Supervisors	Dr Kevin Wood (Wildfowl and Wetlands Trust) Dr Alex Nicol-Harper (Wildfowl and Wetlands Trust) Dr Emilie Hardouin (Bournemouth University) Professor Anita Diaz (Bournemouth University)
Recent publications by supervisors relevant to this project	Boakes, Z., Stafford, R., Bramer, I., Cvitanović, M., **Hardouin, E.A.** (in press). The importance of urban areas in supporting vulnerable and endangered mammals. Urban Ecosystems. **Diaz A.**, Walls S., Whitmarsh D., Smith M. and Green I. (2017). Habitat Selection of Invasive Sika Deer *Cervus nippon* Living in a UK Lowland Heathland-Woodland-Grassland Mosaic: Implications for Habitat Conservation Management. Journal of Scientific Research & Reports 17, 1-15. **Hardouin, E.A.**, Butler, H., Cvitanović, M. et al. (2021) Wildlife conservation in a fragmented landscape: the Eurasian red squirrel on the Isle of Wight. Conservation Genetics, 22, 571–583. https://doi.org/10.1007/s10592-021-01380-z Oldeland, J., Žydelis, R., Dorsch, M., **Stillman, R.A.** & Nehls, G. (2023). Individual-based modelling supports environmental impact assessment in a large-scale construction project. Environmental Impact Assessment Review, 101, 107150. **Nicol-Harper, A.**, Doncaster, C.P., Hilton, G., **Wood, K.A.** & Ezard, T.H.G. (2023). Conservation implications of a mismatch between data availability and demographic impact. Ecology and Evolution, 13, e10269.

	Stillman, R.A., Rivers, E.M., Gilkerson, W., **Wood, K.A.**, Nolet, B.A., Clausen, P., Wilson, H.M. & Ward, D.H. (2021). Predicting impacts of food competition, climate and disturbance on a long-distance migratory herbivore. Ecosphere, 12, e03405. **Wood, K.A.**, **Stillman, R.A.**, Newth, J.L., Nuijten, R.J.M., Hilton, G.M., Nolet, B.A. & Rees, E.C. (2021). Predicting avian herbivore responses to changing food availability and competition. Ecological Modelling, 441, 109421. Brown, S. & **Stillman, R.A.** (2021). Evidence-based conservation in a changing world: lessons from waterbird individual-based models. Ecosphere, 12, e03632. **Nicol-Harper, A.**, **Wood, K.A.**, Diamond, A.W., Major, H., Petersen, A., Tertitski, G., Doncaster, C.P., Ezard, T.H.G. & Hilton, G.M. (2021). Aggregating vital rate estimates for the common eider Somateria mollissima, a data-rich exemplar for the seaduck tribe. Ecological Solutions and Evidence, 2, e12108. **Wood, K.A.**, **Stillman, R.A.** & Hilton, G.M. (2018). Conservation in a changing world needs predictive models. Animal Conservation, 21, 87–88. **Wood, K.A.**, **Stillman, R.A.** & Goss-Custard, J.D. (2015). Co-creation of individual-based models by practitioners and modellers to inform environmental decision-making. Journal of Applied Ecology, 85, 810–815. **Stillman, R.A.**, Railsback, S.F., Giske, J., Berger, U. & Grimm, V. (2015). Making predictions in a changing world: the benefits of individual-based ecology. BioScience, 65, 140-150. Uzal, A., Walls, S., **Stillman, R.A.** & **Diaz, A.** (2013). Sika deer distribution and habitat selection: the influence of the availability and distribution of food, cover, and threats. European Journal of Wildlife Research, 59, 563-572.

INFORMAL ENQUIRIES

Please contact the lead supervisor on the following email for informal enquiries: rstillman@bournemouth.ac.uk

ELIGIBILITY CRITERIA

The BU PhD and MRes Studentships are open to UK, EU and International students.

Candidates for a PhD Studentship should demonstrate outstanding qualities and be motivated to complete a PhD in 4 years and must demonstrate:

- outstanding academic potential as measured normally by either a 1st class honours degree (or equivalent Grade Point Average (GPA) or a Master's degree with distinction or equivalent
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

Candidates for an MRes Studentship should demonstrate outstanding qualities and be motivated to complete a MRes in 18 months and must demonstrate:

- outstanding academic potential as measured normally by an upper second class honours degree (or equivalent Grade Point Average (GPA)
- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

HOW TO APPLY

Please complete the online application form by **the deadline on the project webpage.**

Further information on the application process can be found at: www.bournemouth.ac.uk/studentships