Investigating demographic parameters in birds: Effect of fitness, species' interaction and climate change

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Over the last century, many wildlife species have significantly declined and many others face potential extinction due to threats such as climate change, invasive species, and illegal hunting, among many other factors. There are many things affecting demographic parameters in birds, and hence, understanding the factors affecting wildlife populations allow us to improve the management and conservation of animal populations. For example, it is well known that fitness (understood as the ratio weight/size) may affect survival probabilities in many bird species. Further, the species may interact do not live in isolation but may compete, for example, for the same resources. In the last decades, conservation research has moved beyond species-level estimations adopting a multispecies approach that allow us to obtain a better understanding of the population or ecosystem of interest .

This project will focus on the framework of capture-mark-recapture (CMR) methods (McCrea and Morgan, 2014; King, 2018). The associated models fitted to CMR data account for imperfect detection through the estimation of detection probabilities, providing the link between what we observe and the underlying state of the system. The data collection protocol consists of observers going into the field at a series of capture events, denoted $t = 1, \ldots, T$. At each capture event, previously unobserved individuals are uniquely marked, previously observed individuals are recorded, and all are released them back into the population. The data then correspond to the capture histories of each individual observed throughout the study, detailing at which capture occasions they are observed.

In this project we will focus on the long-term capture-recapture database (1997-2020) of three different bird species wintering in Valencia (Spain) – blackcap, chiffchaff and robin. Two of the three species considered (blackcap and chiffchaff) are not necessarily territorial to their winter grounds, i.e. they are transients and thus, further practical considerations may be investigated to more accurately estimate demographic parameters of interest. Moreover, for these species, survival within the first year of life (juveniles) is lower than for older birds (adults), and hence, age will be an important covariate to include within any such survival models. Finally, multi-species relationships may also be of interest (Lahoz-Monfort et al., 2011).

The aim of this project is to address one, more (or a variant) of the following issues of interest:

- Estimation of inter-winter juvenile and adult survival probabilities for the three species separately and/or jointly.
- Estimation of intra-winter survival probabilities for the three species separately and/or jointly.
- Development of approaches for jointly estimating inter-winter and intra-winter survival.
- Estimation of annual population sizes at the winter grounds.
- Study of the possible association between fitness and survival probabilities.
- Effect of climate change on these species. Does it affect equally at the three species? Due to climate change the winters are now generally warmer and thus, many birds may potentially not migrate to their original winter grounds.
- Species interaction. How to develop an integrated approach including a species-dependence parameter to improve the precision of the estimates.

Students will carry out all the statistical analysis using either a classical and/or Bayesian approach. Fitting the models to the data will require writing bespoke functions in R (or Python) and use of inbuilt black-box optimiser/MCMC routines (for example JAGS or NIMBLE). Some associated likelihood functions for capture-recapture likelihoods are available as open source codes on-line.

References

King, R. (2014). Statistical Ecology. *Annual Review of Statistics and its Application,* 1: 401-426.

Lahoz-Monfort, J.J., Morgan, B.J.T, Harris, M.P., Wanless, S. Freeman, S. (2011). A capture-recapture model for exploring multi-species synchrony in survival. *Methods in Ecology and Evolution*, 2(1): 116-124.

McCrea, R. and Morgan, B.J.T. (2015). *Analysis of Capture-Recapture Data.*