Explicitly testing for population trends using noisy ecological data

Accurately estimating population trends is an important goal of ecological monitoring with major implications for endangered species and their populations. We here present a Bayesian model that directly infers such changes in population trends while accounting for the uncertainty associated with noisy survey data. By focusing on change, our method naturally allows to combine data from multiple survey methods such as track counts, camera trap images or distance sampling records. We focus on answering two relevant questions for ecological management: (1) Is a population increasing or decreasing in size? (2) Has a population trend changed after a specific intervention? This knowledge provides a direct way to evaluate an intervention or policy change by testing whether a negative trend is slowed or even possibly reversed. It also acts as an early warning tool in case of a novel or increased threat (e.g. intensified poaching) by testing whether a negative trend is increased. We can address these questions by determining the posterior probabilities of the rate parameter in our model. Importantly, absolute abundances are not required to answer these questions: the parameters of interest are readily inferred from measures proportional to absolute abundances only. We gain additional statistical power by modelling the sampling process explicitly, in contrast to linear models of population trends that may include observational effort as a covariate. To show its applicability, we ran our model on time series camera trap and track count data from 2012-2020, sampled in the Chinko Nature Reserve in Central Africa. We show that population trends of all apex predator species (lion 'Panthera leo', leopard 'Panthera pardus', spotted hyena 'Crocuta crocuta' and wild dog 'Lycaon pictus') recovered from a steady decline after the beginning of active law enforcement in 2016 and the introduction of strict controls around the park to keep pastoralists and their livestock out.