

Linking breeding outcome to the unknown time of arrival at the breeding site; a study of great tits

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Abstract: Arrival time at a breeding site is likely to reflect the costs of dispersal incurred by individuals during dispersal. It is of interest to determine whether these costs are reflected in subsequent breeding success.

The data set considered in this paper comes from an intensively monitored population of great tits *Parus major* in Wytham Woods, near Oxford, UK. Great tits arrive at the site throughout the non-breeding season and are sampled using both mist nets and automated logging detection systems. During the breeding season, individuals that have established nests are sampled by scanning the nest boxes and/or by physical capture.

We develop models, motivated by this study but generally applicable to other breeding populations, that combine the data sets collected during both the non-breeding and the breeding seasons and allow for different types of sampling and changes in the probabilities of detection after the first encounter. These models estimate the total number of birds present at the breeding site, their arrival pattern at the site, as well as the probability of a bird becoming a breeder and subsequently the probability of that bird successfully fledging chicks. Both these probabilities are allowed to depend on the unknown time of arrival at the site.

Our results suggest that early arrivals have a considerably greater probability of becoming breeders compared to late arrivals but once a bird has become a breeder, the probability of successfully fledging chicks is independent of its arrival time.

These models have a wide range of applications since they can easily be adjusted to different species or sampling techniques and they are a valuable tool for modelling the effects of changes in arrival times at breeding sites on breeding outcome.