

FEATURE ARTICLES

USE OF SURVIVAL TIME ANALYSIS TO ANALYZE NESTING SUCCESS IN BIRDS: AN EXAMPLE USING LOGGERHEAD SHRIKES

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Abstract. Ornithologists commonly estimate nest survival using the Mayfield method, which produces relatively unbiased estimates provided that key assumptions are met. However, this method cannot statistically model nest failure in relation to quantitative variables, nor can it consider the joint effects of two or more independent variables. We demonstrate the use of an alternative method, survival time analysis. Survival time analysis can incorporate nests that are found at different points in the nesting cycle and nests whose ultimate outcome is unknown. The method allows one to examine variation in nest mortality during the course of the nesting period. To demonstrate this method we analyze data on Loggerhead Shrike (*Lanius ludovicianus*) nests, collected as part of a 3-year monitoring program of shrubsteppe habitat in north-central Oregon. We evaluate nesting success with respect to laying date, nest height, and annual variation in failure rate. We demonstrate three types of analyses: Kaplan-Meier estimation (a nonparametric method), Cox proportional hazards model (a semiparametric method), and Weibull parametric regression. Using these maximum-likelihood methods one can carry out likelihood-ratio tests and Akaike's Information Criterion model selection. The best predictive model included the effects of date and year. Nest failure rate changed during the nesting cycle and was heterogeneous among nests, thus violating assumptions of the Mayfield method. We discuss drawbacks to the use of logistic regression (another Mayfield alternative) to analyze nest success. Estimates of the age of a nesting attempt upon discovery are required for survival time analysis; we encourage ornithologists to collect such information.

Key words: breeding date, Cox proportional hazards model, Kaplan-Meier function, logistic regression, Mayfield method, nest failure, survival analysis.