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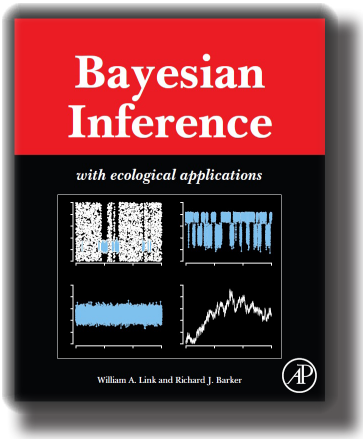
Patuxent Wildlife Research Center

Development of Statistical Methods for Biological Applications

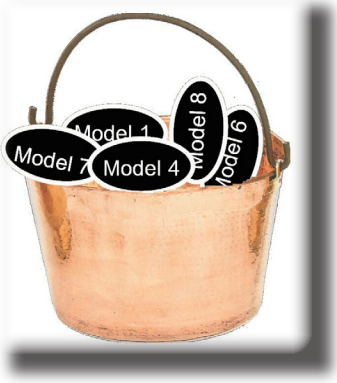
- ***The Challenge:*** Wildlife science and management are guided by data, and it is unquestionably the case that the greatest success occurs when good data are analyzed by good statistical methods.
- ***The Science:*** This study provides the basis for collaboration between a mathematical statistician and quantitative ecologists. One such collaboration has led to the development of techniques for aging Dwarf crocodiles (Osteolaemus tetraspis), informed by model based analysis of two data sets, one consisting of young crocodiles of known age, another consisting of recapture data for older crocodiles of unknown age.

A major product of the study has been the recent publication of the book *Bayesian Inference, with Ecological Applications* by W.A. Link and R.J. Barker. The Bayesian approach to statistical inference was first described in Thomas Bayes' "An Essay towards solving a Problem in the Doctrine of Chances" published posthumously in 1763. Bayesian methods were largely ignored in the early twentieth century, but their usefulness for describing complex models, in concert with advances in computational capacity, has led to a surge of interest, which is revolutionizing statistical analysis. A wildcard search for " Bayes* " in the text of publications of the Ecological Society of America provides an index to the phenomenon: 3 publications are found for 1990-1994, 45 for 1995-1999, 130 for 2000-2004, and 302 for 2005-2009. Link and Barker's text has been well received, not only as an introduction to the Bayesian paradigm, but also for its presentations of Bayesian analysis of a variety of ecological and wildlife data.



- ***The Future:*** The Bayesian paradigm is a mathematically sound and reliable basis for multimodel inference. Bayesian multimodel inference (BMI) has been and continues to be an important component of this study. Two difficulties need to be addressed.

The first has to do with prior distributions, which are the starting point of Bayesian analyses. Prior distributions are readily constructed as summaries of existing knowledge; it is a more challenging problem to choose priors representing an absence of knowledge. For many problems, a variety of "objective" priors exists. Fortunately, the choice among these has little bearing on inference in typical Bayesian applications. However, what may be an innocent choice in single model inference can have substantial implications in multimodel analysis. This study will include continued development of what have been termed "nonpreferential priors," priors appropriate for objective multimodel inference.



A second difficulty involves computational methods for BMI. Computational methods for standard Bayesian models are generally available and readily implemented, though with a degree of care. However, BMI presents computational challenges that have hitherto limited its application. The usual approach is through Reversible Jump Markov chain Monte Carlo (RJMCMC). A goal of this study is to develop methods of RJMCMC to make it more widely accessible to practitioners.

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