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James S. Clark: Models for Ecological Data

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Models in Context

1.1 Complexity and Obscurity in Nature and in Models

This book deals with the use of data and models that can enhance understanding and contribute to prediction. These two goals are complementary. Both involve inference, and model analyses can take the form of predictive distributions. For environmental scientists, the challenge stems from the fact that natural and managed systems are high-dimensional, meaning that many interacting forces are at work (Levin 1998; Clark 2005; Clark and Gelfand 2006a). Much of nature is unmeasurable, unobservable, or both. Much cannot be manipulated. Faced with obscure, complex, and uncontrolled processes, environmental scientists have long recognized the need for abstraction (Schaffer 1981; Caswell 1988). Theoreticians and experimentalists attempt to extract the important relationships from nature so they can be studied in a controlled setting. Ecologists write models with only a few variables and parameters. They design experiments with only a few treatments.

The need to simplify on both the theoretical and experimental sides leaves a gap that can isolate those who analyze ecological models from those who collect and draw inference from data. This gap makes it difficult to test theory with data and to model data in appropriate ways (e.g., Oreskes et al. 1994). The goal of this book is to describe methods that can help to bridge the gap, starting from concepts that underlie traditional process and statistical models, and moving toward modern techniques that allow for deeper integration. This introductory chapter starts with some background and motivation.

1.1.1 Why Ecological Models Are Low-Dimensional

Attempts to abstract key features of a process are an important component of all scientific disciplines. From the conceptual (theory) side, this abstraction is accomplished with process models that contain few variables and parameters. High-dimensional process models are intractable; without simplified models, they cannot be analyzed to yield transparent relationships. Complex process

