# IV.1 What Modeling Is and How It Works

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A range manager and a modeler have at least four traits in common. Both respect intuition and experience, both are subject to bias, both are exposed to risk, and both do the best they can with the information that is available. Those range managers who believe that two or more heads can solve a problem better than one are encouraged to read on about modeling. In a recent book about modeling insect populations, Goodenough and McKinion (1992) describe a model as “a representation of a real system,” and then define a system as “a collection of a number of elements or components which are interconnected to form a whole.”

How does modeling work? First, modeling uses mathematical symbols and processes to express relationships that, as scientists and land managers, we think we understand or that seem reasonable. The knowledge or logic is greatly condensed into extremely efficient statements called formulae. This usually is possible only after a lot of clear thinking, problem definition, and trial-and-error evaluations have taken place. Next, the formulae are imbedded in a computer program. Doing this requires a rigid format for reasoning that requires each user to consider every important element. Finally, the user provides as many details as possible about as many elements or components as necessary, after which the model calculates a likely representation of response by the system.

The least complex systems contain few elements and are open to few outside influences. A simple example is a hydraulic jack. If one assumes no leaks and essentially 100-percent efficiency, each stroke of the handle yields a result that can be predicted exactly. Rangeland obviously represents an opposite extreme of complexity, with its multitude of physical forces plus plants and animals of all sizes, each affecting each other in ways that often are unknown. As land managers and scientists, we do not pretend that we can precisely model the entire system, but we are confident that we can model some elements to a useful degree.

The chapters in this section all discuss interrelationships among elements or components of rangeland ecosystems that are important to grasshopper management. A small proportion of that prose already has been translated into mathematical language and is being used in the grasshopper model portion of Hopper (the decision support tool that is described in VI.2). Examples include the time and rate of grasshopper development as a function of temperature, forage consumption as a function of grasshopper size and density, and expected responses of grasshopper populations to management tactics.

For a variety of reasons, the overwhelming majority of the following chapters is not yet available in management-oriented models. In some cases, like soil temperature–egg development relationships, the information was acquired only recently. In other cases—like relationships between weather, host plant quality, grasshopper food consumption, and grasshopper population dynamics—causes and effects have not yet been precisely quantified. In still other cases, like predicting outbreaks, scientists and land managers cannot yet calculate which one of several likely events will eventually occur. The information nevertheless is being presented in narrative form, intended both to establish the current state of knowledge about grasshopper population dynamics and to expedite future modeling efforts.

For additional insights about what modeling is and how it works, you are encouraged to study appendix A of the Hopper Users’ Guide (VI.2). Also, chapters in section VII discuss models that probably will be developed in the near future.

## Reference Cited

Goodenough, J. L.; McKinion, J. M. 1992. Basics of insect modeling. Monogr. 10. St. Joseph, MI: American Society of Agricultural Engineers. 221 p.