Chapter 1: Linear Difference Equations (Theory)

Section 1.1: Introduction

There are three basic steps in mathematical modeling of biological systems.

1. Formulation of a mathematical model to represent accurately the underlying biological system under consideration.

2. Application of mathematical techniques to understand the model behavior.

3. Interpretation of the model results to determine whether meaningful biological results are obtained.

In order to apply these three steps, the underlying mathematical theory, tools, and techniques must be carefully and thoroughly understood.

Mathematical models of biological systems are often expressed in terms of difference or differential equations. The reason for this is that biological systems are dynamical, changing with respect to time, space, or stage of development. Therefore, the three steps in mathematical modeling require a good understanding of the mathematical theory for both difference and differential equations.

Difference equations are relationships between quantities as they change over discrete time intervals \( t = 0, 1, 2, \ldots \). Differential equations describe changes in quantities over continuous time intervals \( 0 \leq t < \infty \). The quantities modeled by the difference or differential equations are called states of the system.

Difference equations are applied frequently to populations whose generations do not overlap. That is, when a species dies after giving birth to the next generation. Discrete time intervals often coincide with periodic data collection used in the laboratory or in the field. Differential equations are applied when changes in the states occur continuously such as in the case of continuous reproduction and death.

There are many good texts on mathematical modeling of biological systems including, but not limited to,


