

ABSTRACT

BEHAVIORAL AND STABILITY ANALYSIS OF THE LOTKA–VOLTERRA DISCRETE PREDATOR–PREY MODEL ON VARIATION IN INTERSPECIFIC COMPETITION

By

Dwi Rizka Amelia Putri

This study analyzes the behavior and stability of the Lotka–Volterra discrete predator–prey model by considering variations in the level of interspecific competition and the effect of disease on the population. The continuous model is discretized using a nonstandard finite difference scheme method to maintain the stability and positivity of the solution. The analysis is carried out by determining the equilibrium point and its stability properties through the Jacobian matrix and eigenvalues, as well as a sensitivity study of biological parameters including competition between prey, competition between predators, predation rate, effectiveness of prey-to-prey conversion, and disease rate. Numerical simulations using MATLAB are applied to describe the long-term population dynamics. The results show that increased competition between prey decreases the prey population due to resource limitations and impacts the decline of the predator population due to reduced prey, while increased competition between predators decreases the predator population due to internal competition, thus reducing predation pressure and increasing the prey population. The nonstandard finite difference scheme method is proven to be able to maintain the stability and biological properties of the model.

Keywords: predator–prey, discrete Lotka–Volterra, nonstandard finite difference schemes, competition, system stability.

ABSTRAK

ANALISIS PERILAKU DAN KESTABILAN MODEL PREDATOR–PREY DISKRIT LOTKA–VOLTERRA TERHADAP VARIASI KOMPETISI ANTARSPESES

Oleh

Dwi Rizka Amelia Putri

Penelitian ini menganalisis perilaku dan kestabilan model predator–prey diskrit Lotka–Volterra dengan mempertimbangkan variasi tingkat kompetisi antarspesies dan pengaruh penyakit pada populasi. Model kontinu didiskritisasi menggunakan metode skema beda hingga tak standar untuk menjaga kestabilan dan kepositifan solusi. Analisis dilakukan dengan menentukan titik kesetimbangan dan sifat kestabilannya melalui matriks Jacobian dan nilai eigen, serta kajian sensitivitas parameter biologis yang meliputi kompetisi antar prey, kompetisi antar predator, laju predasi, efektivitas konversi prey menjadi predator, dan laju penyakit. Simulasi numerik menggunakan MATLAB diterapkan untuk menggambarkan dinamika populasi dalam jangka panjang. Hasil penelitian menunjukkan bahwa peningkatan kompetisi antar prey menurunkan populasi prey akibat keterbatasan sumber daya dan berdampak pada penurunan populasi predator karena berkurangnya mangsa, sedangkan peningkatan kompetisi antar predator menurunkan populasi predator akibat persaingan internal sehingga tekanan predasi berkurang dan populasi prey meningkat. Metode skema beda hingga tak standar terbukti mampu mempertahankan kestabilan serta sifat biologis model.

Kata-kata kunci: predator–prey, Lotka–Volterra diskrit, penyakit, skema beda hingga tak standar, kestabilan sistem.