Bifurcation and Chaos Analysis for a Discrete Ecological Developmental Systems

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Abstract

This work concentrates on the dynamic analysis including bifurcation and chaos of a discrete ecological developmental systems. Specifically, it is a prey-predator-scavenger (PPS) system, which is derived by Euler discretization method. By choosing the step size h as a bifurcation parameter, we determine the set consist of all system's parameters, in which the system can undergo flip bifurcation (FB) and Neimark-Sacker bifurcation (NSB). The theoretical results are verified by some numerical simulations. It is shown that the discrete systems exhibit more interesting behaviors, including the chaotic sets, quasiperiodic orbits, and the cascade of period-doubling bifurcation in orbits of periods-2, 4, 8, 16. Finally, corresponding to the two bifurcation behaviors discussed, the maximum Lyapunov exponent is numerically calculated, which further verifies the rich dynamic characteristics of the discrete system.

Full Text

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Figures

Figure 1

(a) Bifurcation diagram of system (2) in $(h; x)$ plane with the initial value $(0:4; 0:2; 0:3)$; (b) The largest Lyapunov exponents associated with (a).

(a)

(b)

Figure 2

(a) Local amplification corresponding to Fig.1 for $h \in [0.18; 0.205]$; (b) The largest Lyapunov exponents associated with (a).

Figure 3

Phase portrait for different values of bifurcation parameter h .

Figure 4

(a) Bifurcation diagram of system (2) in $(h; x)$ plane with the initial value $(1:5; 0:2; 0:4)$; (b) The largest Lyapunov exponents.

Figure 5

(a) Local amplification corresponding to Fig.6 for $h \in [0.35; 0.38]$; (b) The largest Lyapunov exponents associated with (a).

Figure 6

Phase portrait for different values of bifurcation parameter h .