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Bifurcation analysis and control of a discrete harvested prey-predator system with Beddington-DeAngelis functional response. (English) Zbl 1210.92062

J. Franklin Inst. 347, No. 7, 1076-1096 (2010).

The authors study a discrete prey-predator system with harvesting of both species and Beddington-DeAngelis functional response. By using the center manifold theorem and bifurcation theory, they establish that the system undergoes flip and Hopf bifurcations when the harvesting effort of the prey population passes some critical values. Numerical simulations exhibit period 6, 10, 12, 14, 20 orbits, cascades of period-doubling bifurcations in period 2, 4, 8, 16 orbits and chaotic sets. The numerically computed Lyapunov exponents confirm the complex dynamical behaviors. Moreover, a state delayed feedback control method, which can be implemented only by adjusting the harvesting effort for the prey population, is proposed to drive the discrete prey-predator system to a steady state.

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MSC:

92D40	Ecology
39A28	Bifurcation theory for difference equations
93C95	Application models in control theory
37N25	Dynamical systems in biology
39A33	Chaotic behavior of solutions of difference equations
65L12	Finite difference and finite volume methods for ordinary differential equations
65C20	Probabilistic models, generic numerical methods in probability and statistics
39A60	Applications of difference equations

Keywords:

flip bifurcations; Hopf bifurcations; state delayed feedback control; chaos; Lyapunov exponents

Full Text: DOI

References:

[1] Kar, T.K.; Pahari, U.K., Modeling and analysis of a prey – predator system with stage-structure and harvesting, Nonlinear analysis, 8, 601-609, (2007) · Zbl 1152.34374

[2] Xiao, D.M.; Li, W.X.; Han, M.A., Dynamics in ratio-dependent predator – prey model with predator harvesting, Mathematical analysis and applications, 324, 14-29, (2006) · Zbl 1122.34035

[3] Kumar, S.; Srivastava, S.K.; Chingakham, P., Hopf bifurcation and stability analysis in a harvested one-predator – two-prey model, Applied mathematics and computation, 129, 107-118, (2002) · Zbl 1017.92041

[4] Liu, Z.J.; Tan, R.H., Impulsive harvesting and stocking in a monod – haldane functional response predator – prey system, Chaos, solitons \& fractals, 34, 454-464, (2007) · Zbl 1127.92045

[5] Wang, F.Y.; Hao, C.P.; Chen, L.S., Bifurcation and chaos in a monod – haldane type food chain chemostat with pulsed input and washout, Chaos, solitons \& fractals, 32, 181-194, (2007) · Zbl 1130.92058

[6] Wang, F.Y.; Zhang, S.W.; Chen, L.S.; Sun, L.H., Bifurcation and complexity of monod type predator – prey system in a pulsed chemostat, Chaos, solitons \& fractals, 27, 447-458, (2006) · Zbl 1096.34029

[7] Song, X.Y.; Li, Y.F., Dynamic complexities of a Holling II two-prey one-predator system with impulsive effect, Chaos, solitons \& fractals, 33, 463-478, (2007) · Zbl 1136.34046

[8] Peng, R.; Wang, M.X., Global stability of the equilibrium of a diffusive holling – tanner prey – predator model, Applied mathematics letters, 20, 664-670, (2007) · Zbl 1125.35009

[9] Huang, Y.J.; Chen, F.D.; Zhong, L., Stability analysis of a prey – predator model with Holling type III response function incorporating a prey refuge, Applied mathematics and computation, 182, 672-683, (2006) · Zbl 1102.92056

[10] Zhang, S.W.; Tan, D.J.; Chen, L.S., Chaos in periodically forced Holling type IV predator – prey system with impulsive

perturbations, Chaos, solitons \& fractals, 27, 980-990, (2006) · Zbl 1097.34038

[11] Xu, R.; Chaplain, M.A.J.; Davidson, F.A., Periodic solutions for a predator – prey model with Holling-type functional response and time delays, Applied mathematics and computation, 161, 637-654, (2005) · Zbl 1064.34053

[12] Sugie, J., Two-parameter bifurcation in a predator – prey system of ivlev type, Journal of mathematical analysis and applications, 217, 349-371, (1998) · Zbl 0894.34025

[13] Kooij, R.E.; Zegeling, A., A predator – prey model with Ivlev's functional response, Journal of mathematical analysis and applications, 198, 473-489, (1996) · Zbl 0851.34030

[14] Xu, C.Y.; Wang, M.J., Permanence for a delayed discrete three-level food-chain model with beddington – deangelis functional response, Applied mathematics and computation, 187, 1109-1119, (2007) · Zbl 1120.92049

[15] Zhang, J.M.; Wang, J., Periodic solutions for discrete predator – prey systems with the beddington – deangelis functional response, Applied mathematics letters, 19, 1361-1366, (2006) · Zbl 1140.92325

[16] Bohner, M.; Fan, M.; Zhang, J.M., Existence of periodic solutions in predator – prey and competition dynamic systems, Nonlinear analysis, 7, 1193-1204, (2006) · Zbl 1104.92057

[17] Guckenheimer, J.; Holmes, P., Nonlinear oscillations, dynamical systems, and bifurcations of vector fields, (1983), Springer-Verlag New York · Zbl 0515.34001